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Yesterday's Ideas . . . and Tomorrow's

. . . Much has been, and still can be, said about replacement of equipment that has outlived its usefulness. In truth, the importance of keeping a plant at the highest degree of efficiency by discarding the old as soon as something better comes along, cannot be over-emphasized. Of equal or even greater moment is the necessity of having a mental housecleaning once in a while, to clear out the antiquated ideas and standards that are certain to accumulate.

. . . After all, ideas are the biggest force in the world. It is only by changing his ideas and ideals that Man has advanced from the bearskin and stone-ax age to the present day of silks and diamonds, automobiles and mass production.

. . . One hardly realizes how fast conditions and viewpoints change until he looks back ten, or fifteen, or even five years. Then, if he possesses experience and a good memory, he can visualize the progress that has been made in practically every phase of human activity. To consider industry alone, everyone knows we are turning out a multitude of products that were unheard of a few years ago, and have improved all manner of industrial operations to a point that would have been thought almost impossible not many years since. Such progress has placed us as a nation in an enviable position, but it has been made possible only because we have had enough industrial leaders who were willing to scrap equipment, ideas, and everything else that could be replaced with something better.

. . . Before a plant can be brought up to date, the idea that equipment should be kept in operation until it falls apart, must be replaced by the conviction that it is good economy to junk any device that does not measure up to modern standards of performance. Before the cost of handling raw materials and parts can be cut to the minimum, the belief that strong arms and backs can successfully compete with modern conveyors, electric trucks, and cranes, must be radically changed.

. . . With the rapid increase in the size and complexity of industrial plants, and the installation of highly efficient but costly equipment, there has, and must, come a new conception of the importance of proper inspection and care. With factories so highly organized that a shutdown in one department may seriously affect the production of the entire plant, breakdowns become too costly to be tolerated. In the words of one plant engineer, "Nowadays we must remedy troubles before they happen."

. . . The designer and artisan build into their product as much efficiency and trouble-free operation as possible, but intelligent operation and care are required to secure the maximum possible performance.

. . . Many ideas and ideals lose their effectiveness and become out of date, in time. The man or the organization that forges ahead is the one that is constantly replacing the ideas of yesterday and today with those of tomorrow.

Unattended Operation for Industrial

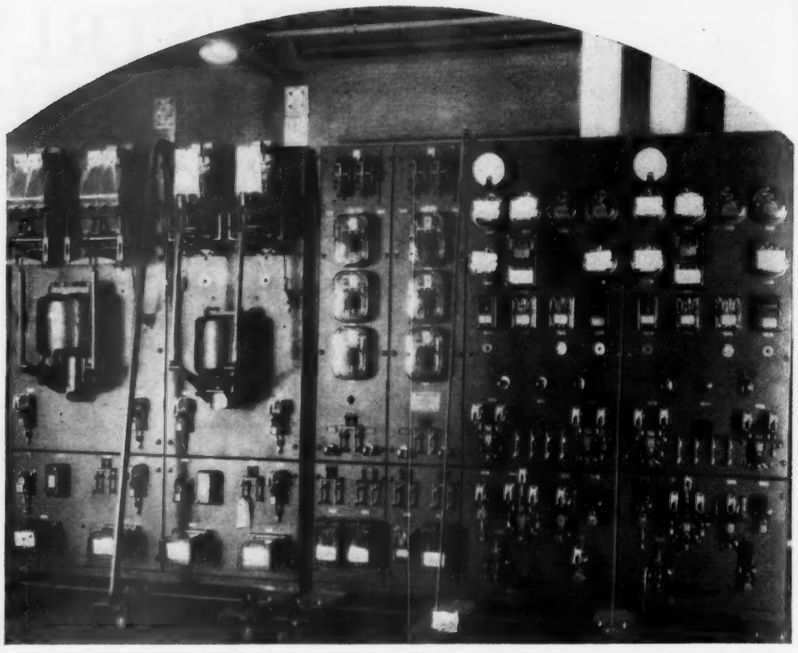

Fig. 1—Automatic control panels for two 250-volt synchronous motor-generator sets, one of 1,000 kw. and the other 1,500 kw. capacity.

SUBSTATIONS

How automatic equipment makes it economically feasible to distribute the entire substation capacity throughout the plant system

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IN THE modernization of all classes of direct-current power systems, automatic operation is now very generally accepted as an essential element. The better economy and increased reliability to be effected through the use of automatic equipment have been thoroughly demonstrated in a wide variety of installations. In the railway field, where the automatic substation was pioneered, over 80 per cent of the new conversion units installed in recent years have been equipped for automatic operation and, in addition, numerous old units have been automatized. In the mining industry, perhaps 50 per cent of the new conversion capacity is being installed with automatic switching equipment, and a large number of existing units are being similarly equipped. In the steel mills, the appreciation of the many advantages of automatic operation is gaining ground so rapidly that it is difficult to make a definite estimate. Similar benefits can be realized in the general industrial field requiring direct current, through the use of correctly applied apparatus operating in a properly co-ordinated system.

In any consideration of new equipment, or in the rehabilitation of old equipment, it is important that the whole system be carefully studied and analyzed, if best results are to be obtained. Most industrial d.c. systems have grown up under the limitations imposed by steam driven equipment and manual operation, with the result that the whole system capacity is concentrated in one large station. In many long established plants, power is still generated by old, slow-speed d.c. generators driven by reciprocating steam engines. Power losses in both the engines and the generators are excessive, a considerable force of men is required for operation and maintenance, and a large amount of valuable floor space is needlessly taken up. In such cases striking economies can be effected by changing over to modern, high-speed, efficient conversion units, and unattended automatic operation.

By eliminating the necessity for constant attendance at each substation, automatic equipment makes it economically feasible to distribute the substation capacity throughout the system. The proper locations can be found by a study of the nature and magnitude of the individual loads, from which the natural load centers of the system can be determined.

The resultant saving in distribution losses is, in many cases, of considerable magnitude. In some larger systems this saving in distribution losses alone, has proved sufficient to justify the required capital expenditure for automatic equipment.

In considering multiple unit stations, or multiple station systems, it is necessary to bear in mind the fundamentals of parallel operation. Stability and satisfactory division of load between stations in any d.c. distribution system can be obtained only through drooping voltage characteristics at the station buses, a drooping voltage characteristic in the distribution system, adjustment of the station voltages to various values, or a combination of these.

Were it possible to maintain an absolutely steady load at all points on the system, the stations could be made to divide the load properly, with only a relatively small droop in the distribution system and with flat station bus characteristics by adjusting the various station voltages to proper values. Such a system would be stable under normal conditions, but would probably topple over as the result of an a.c. system disturbance. For example, consider a fault in the a.c. system of such nature as to result in failure of a.c. supply to one station, necessitating the removal of that station from service. Since the stations immediately adjacent would maintain a constant bus voltage regardless of load conditions, they would continue to carry their own load and, in addition, would assume the entire load of station at fault. The resultant heavy overload would either trip their d.c. breakers or would soon necessitate their removal from service to prevent overheating, thus passing the load of three stations on to the two next removed. These would, in turn be tripped out on the d.c. end, and so on, until the entire system would be shut down.

Where the load fluctuates rapidly and over any considerable range, it is necessary to limit the difference between the no-load voltages of the various stations in order to prevent outage of the low-voltage stations due to reverse current during the light load periods. On a fluctuating load, then, proper division of load must be accomplished more by droop at the bus or in the system, and less by adjustment of station voltages. If there are periods of zero load, the no-load voltage must be practically the same at all stations, and proper distribution of load among the stations can be effected only by line drop, drooping bus characteristics, or both. Large line drop, or droop in the system, represents large distribution loss and is, of course, to be avoided.

For many years the compound-wound machine, with its practically flat voltage characteristic, was considered best for most classes of service. With the advent of the automatic substation the many desirable characteristics of the shunt, or drooping characteristic were brought to light and it is now being used advantageously in a wide variety of applications.

The compound machine, in maintaining the bus voltage practically constant regardless of load, tends to assume all the load which can be concentrated in its vicinity. Thus, with compound machines the capacity in each station must be sufficient not only to carry its share of the R.M.S. load in the adjacent sections, but it must also be capable of carrying practically all the peak load in the vicinity. Under extreme peak load conditions, or in case of a station outage this will necessitate dropping part of the load, or in many cases will result in system instability, as described herein, before the load can be disconnected. This inherent tendency of the compound machine can be counteracted only by locating the stations a considerable distance from the load in order to introduce sufficient line drop to effect a reasonably good distribution of peaks, or emergency loads between stations. This, however, requires a very large investment in distribution copper, results in excessive distribution losses and defeats the only conceivable reason for considering the compound machine, because of its supposed ability to maintain good voltage at the load under heavy load conditions. In most cases, it can be shown that the peak-load voltage conditions at the load can be materially improved by the use of shunt machines properly located at the load centers.

With the shunt machine, or drooping bus voltage characteristics, the tendency is inherently to shed, rather than assume a heavy load. A station, or machine within a multiple unit station, tends to assume more load only in case it is more lightly loaded than other stations or machines feeding into the same load. An overloaded station is thus rendered assistance in proportion to the individual ability of the connecting stations. In case of nearby peaks or a station outage, each adjacent station in taking on the extra load, immediately lowers its bus voltage and thus shifts part of its previous load to the station next removed. It is unnecessary to adjust the no-load station voltages to different values to effect proper load distribution. The system is, therefore, inherently stable as regards both light load and over-

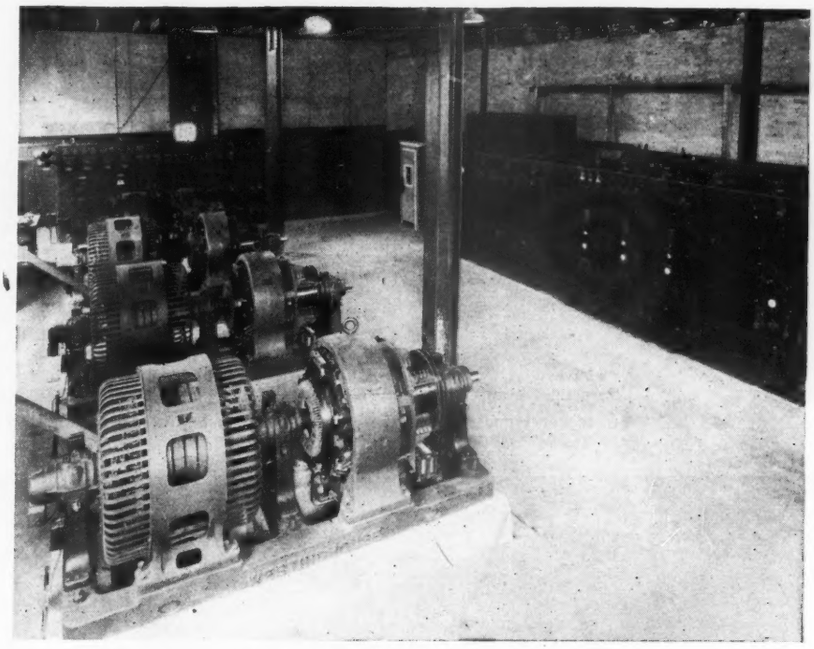


FIG. 2—SPARE EQUIPMENT is essential where there are no other substations to carry through an emergency shutdown. This substation contains three 500 kw., 250-volt synchronous motor-generator sets with provision for an additional unit.

load conditions that are encountered.

The effectiveness of a given droop at the station bus is inversely proportional to the resistance between stations. Even on the relatively high resistance railway systems, the shunt characteristic has proved to be very advantageous and is being almost universally adopted. Steel mill and many other industrial distribution systems might well be likened to widely fluctuating railway loads on low resistance Edison networks. In such combinations, conditions are ideal for realizing the maximum benefit from a drooping bus voltage characteristic.

Although it is possible, with a low resistance equalizer and by sufficient manipulation of the shunt field rheostats, to parallel two or more flat or over compounded d.c. machines on the same bus, it is by no means easy to obtain equal division of load under all load and temperature conditions. Under automatic control, parallel operation with a flat or rising bus characteristic requires special regulating equipment which adds materially to the cost and complexity of the equipment. However, with shunt machines and a drooping bus characteristic satisfactory paralleling is readily obtained. Analysis of a large number of installations of various types shows that it is only in very rare and special cases that a flat or rising bus characteristic is justifiable in a properly designed system.

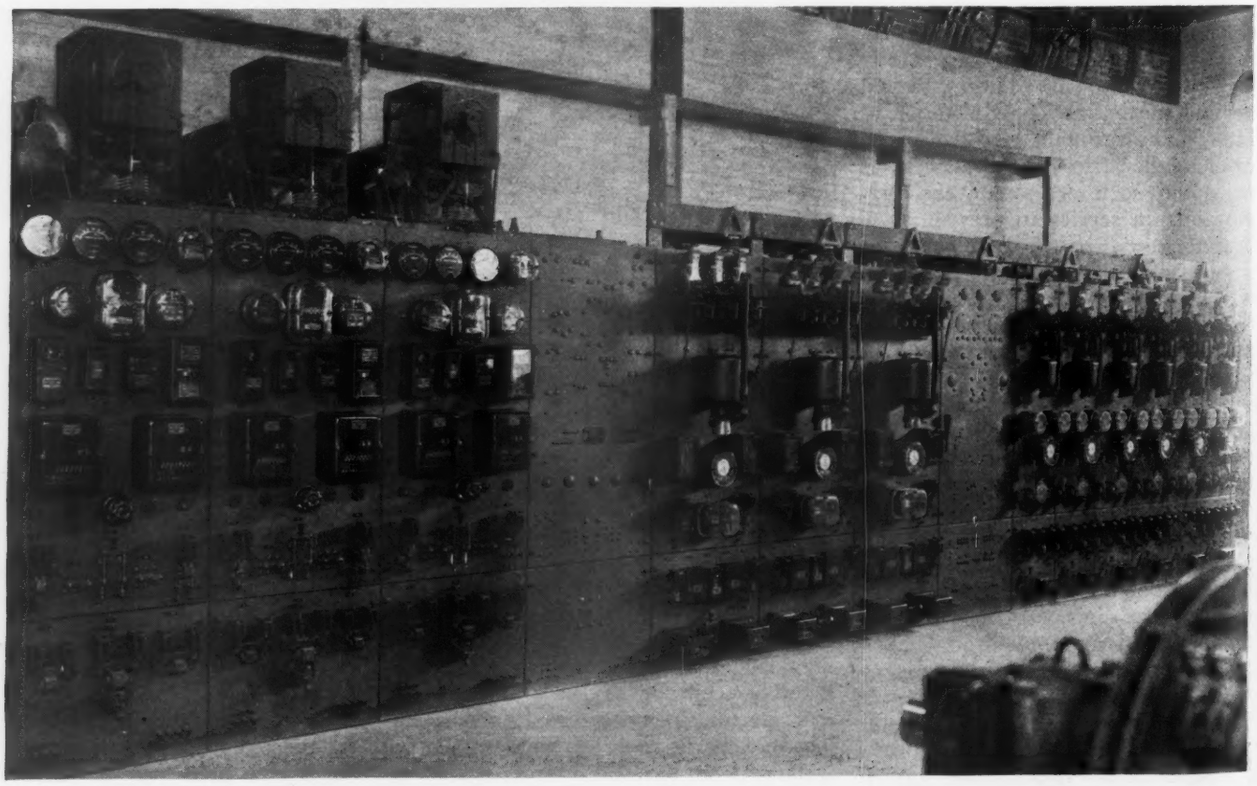
For automatic operation in a low-voltage, low-resistance network where it is necessary to pick up and feed heavy loads at a small percentage of normal voltage, a voltage-balancing and current-limiting regulator is essential. To cover any considerable range such a device requires the use of a separately-excited shunt generator. With this arrangement a machine can be balanced against the bus down to practically zero voltage and can thus pick up a very heavy connected load. A voltage regulating element is also included and provided with a current biasing coil so that any degree of drooping voltage characteristic can be maintained at the station bus. Such equipment is also very desirable in any multiple station system feeding loads of variable magnitude. Whenever the load exceeds a predetermined value, the current limiting regulator takes charge and prevents overloading the machine by lowering the bus voltage sufficiently to shift the load to adjacent stations. With a number of machines rendered inoperative in an emergency their load will by this means be distributed throughout the system and the remaining machines will stick to the load to the limit of their ability, thus preventing a system shutdown. At loads below the setting of the current limiting regulator the voltage regulator takes charge to effect the desired characteristic at the station bus. By adjusting the bias coil on the voltage element, the full-load voltage, and hence the distribution of load between stations, can be adjusted without changing the no-load voltage. The stations can therefore be located at the load centers, thus minimizing the distribution loss without the resultant system instability which would obtain with compound machines due to different no-load voltages.

Fig. 1 shows the automatic switch board for the control of two 250-volt, synchronous motor-generator sets.

In many small and medium-sized industrial plants, the extent of the d.c. distribution system will not warrant the installation of more than one substation. In such cases the machines are usually operated shunt or under-compounded to give a 4 to 6 per cent drooping bus characteristic. With this arrangement it is seldom necessary to provide regulating equip-

(Please turn to page 370)

FIG. 3—IN THE CLOSE-UP of the switchboard the control for the automatic starting sequence panels is shown at the left. The d.c. machine panels are between the spare panels in the center. The six short-circuit, detector-type, automatic-reclosing d.c. feeder panels are at the right. The a.c. breakers and starting auto-transformers are mounted on a balcony above the machines.



What It Pays to Know About

Control Equipment *for* Synchronous Motors

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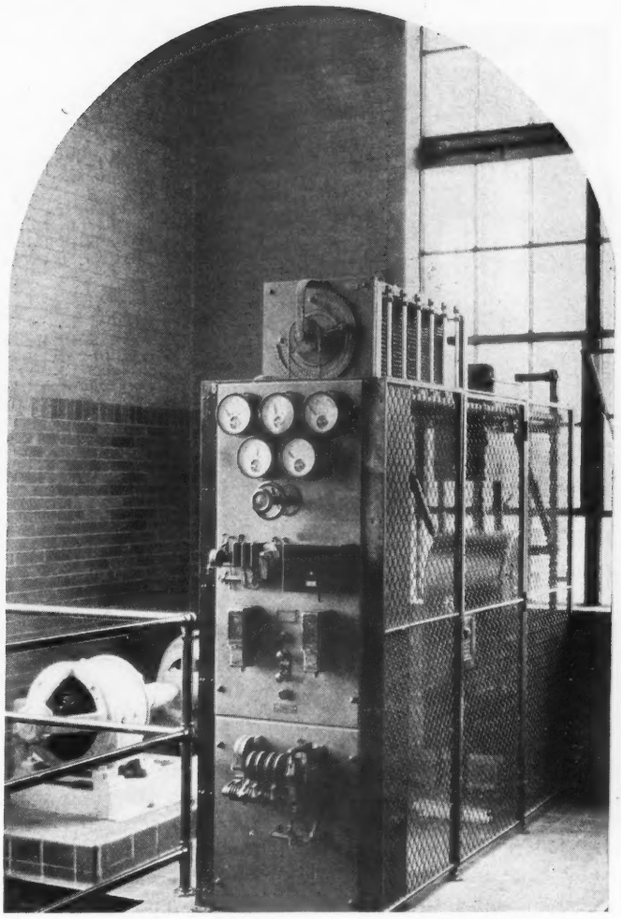


Full-voltage starting panel, with remote-mounted oil circuit breaker, for 500-hp., 2,200-volt synchronous motor.

SUCCESSFUL application of synchronous motors depends to a great extent on the choice of suitable control. In turn, the selection of this equipment involves three considerations:

1. Control that will give adequate starting characteristics.
2. Relays that will afford the necessary protection under operating conditions.
3. Indicating and recording devices to guide the user in operating the motor to the best advantage.

The following elements are necessary for starting and operating any synchronous motor: A line contactor or circuit breaker, a field switch (for the exciter), and an overload relay. If the motor is started on reduced voltage, a starting switch and an autotransformer or a starting resistor must be added.

For practically all synchronous motor controllers, the following equipment may be considered as standard: (1) Line ammeter. (2) Field ammeter. (3) Exciter or motor field rheostat. (4) Field discharge resistor through which the motor field is short circuited when starting and stopping.

Where manual control is used, the operator will determine the time at which to change from reduced to full voltage, and the time at which to apply excitation to the field. If push-button control is used, the panel will include a relay to govern the change from reduced to full voltage (when reduced voltage starting is employed), and a relay to apply excitation to the field when the motor is up to speed.

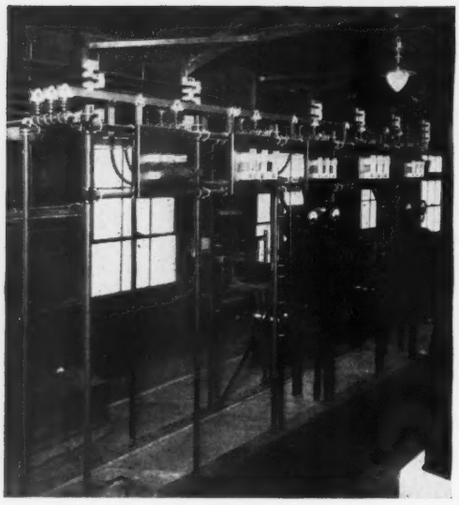
Considering first the question of full voltage starting as compared with reduced-voltage starting, these factors must be considered:

1. The torque required to start and accelerate the load, and its relation to the torque that the motor will develop at full voltage.
2. The amount of starting current drawn by the motor when started on full voltage, and its effect on the line voltage.
3. The mechanical effect of full-voltage starting on the motor and on the driven machine.

In some cases the starting characteristics of the load make it necessary to start the motor on full voltage. This is particularly true of low-speed drives and inertia loads that require a high breakaway torque or a high accelerating torque to bring the machine up to speed within a reasonable length of time. For example, certain types of reciprocating compressors fall in this class.

It is customary to design 60-cycle motors of 450 r.p.m. and below, for full-voltage starting. Unless designed for special requirements, these motors will develop from 35 to 60 per cent of full-load torque at starting, and approximately the same pull-in torque, when started at full voltage, with a starting current of 200 to 350 per cent of the rated full-load current. Because of the low starting current, such motors are generally started at full voltage because of the lower cost and greater simplicity of the control. This practice is followed even in cases where reduced-voltage starting would provide adequate torque.

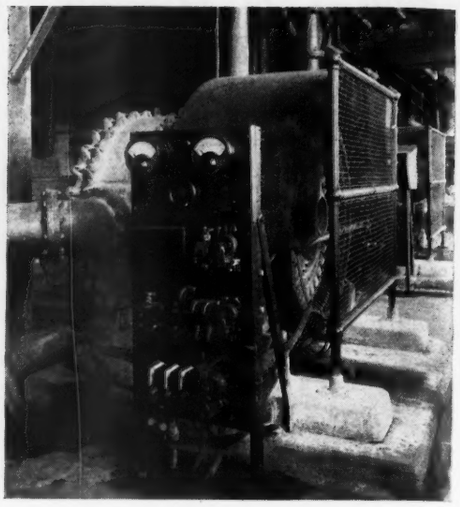
Motors of 600 r.p.m. or higher speeds are designed for more general use. They develop not less than



HAND-OPERATED, reduced-voltage panels for 225-hp., 550-volt synchronous motors. Space has been provided for two additional panels.

* * *

HERE is an across-the-line starter for a 100-hp., 550-volt synchronous motor direct-connected to a vacuum pump.



full-load torque at starting and at all intermediate speeds and are, therefore, suitable for all ordinary applications. However, such motors draw from 4½ to 8 times full-load current if started on full voltage. To reduce the starting current they are usually started at reduced voltage, as there are comparatively few applications of either direct-connected or belted motors that require as much as the full-load torque for breakaway.

Where high-torque motors are involved, it is sometimes necessary to start on reduced voltage to prevent a heavy shock to the driven machine or, in the case of belt drive, to prevent breaking or throwing the belt. In the case of large, high-speed synchronous motors, the strain due to frequent starting on full voltage may injure the stator winding unless the coils are especially braced.

The advisability of adopting full-voltage starting depends also on the voltage drop which the starting current will cause. In many cases the rules of the power company will decide the question. Where no such limitations are involved, the important considerations are: the size of the feeder, the transformer capacity available, and the nature of the other loads connected to the same line. Where a lighting load is connected to the same feeder, the voltage drop must be restricted to a much smaller percentage than would be permissible for motor loads.

Reduced-voltage starting is generally accomplished by the use of a compensator or auto-transformer, or with either self-contained or external switches. Standard compensators are built with three or four taps, any one of which may be connected for use in starting, depending on the torque requirements of the load. As alternatives, a primary resistor or a starting bus may be used or, in some cases, a reconnection of the motor winding.

For motors of average capacity, the primary-starting resistor becomes very bulky in comparison with the compensator. The compensator is a voltage-reducing transformer, whereas the resistor actually dissipates power and must, therefore, have large heat-radiating capacity.

The reduced-voltage bus may be used for starting a group of motors if one voltage value is suitable for all of them. In this case, a single, large auto-transformer is utilized, usually with a spare, to start the motors in turn. Where this arrangement can be applied some saving in first cost may be made as compared with the cost of individual auto-transformers, and the switching arrangement is somewhat simplified.

The Y-delta method of starting depends, first of all, upon having motors that can be delta-connected for normal operation. As the Y connection is generally used for motors, this method of starting is seldom applied. Its use is further limited by the fact that the Y connection for starting delta-connected motors gives only 58 per cent of the line voltage per phase, and no other voltage can be obtained to meet applications that require a higher starting torque.

One important application of primary-resistor starters has developed for starting synchronous or induction motors on low-voltage distribution systems carrying important single-phase lighting loads. For such circuits, many power companies have rigid rules limiting the "amperes per step" or the rate at which the current may be increased in starting a motor. The resistor starting panels are usually built with a number of contactors which close in succession at intervals of ½ to 1 second, cutting out sections of the starting resistor and allowing the motor current to increase gradually. After the resistor is all cut out, and the motor has accelerated to full speed, excitation is applied manually or by a relay which closes the contactor, to synchronize the motor.

The resistor starter offers the simplest method of meeting the requirements in such cases, and has been used for motors as large as 400 hp. when connected to low-voltage lighting and distribution circuits.

In deciding between manually-operated and push-button starters, the following points are of importance:

1. Is the starting load sufficiently definite and uniform to permit "standardized starting" by means of automatic control?

2. Is it desirable to relieve the operator of the necessity of timing the various operations in the starting cycle?

3. Is the plant arranged so that remote control is desirable?

There are a few applications in which the starting conditions are so variable that it is difficult to time the starting operations by automatic control and have this timing suitable under all conditions. Such drives require skillful operators who sense the proper time to perform the various steps in the starting cycle.

In the case of large, high-speed motors with rather elaborate control, the work of actually opening and closing the breakers may interfere with the operator's attention to the machine. This can be overcome by

the use of a control in which the operations are brought about by master switches that are directly controlled by the operator.

The best applications of automatic or push-button starting are those in which the starting procedure is fairly well defined and not subject to much variation. With automatic control the initial adjustment can be made to give the most satisfactory starting, with the assurance that the same procedure will be followed every time the machine is started. Also, the transition from one step to the next is accomplished within a fraction of a second and is positive in operation. Finally, the use of automatic equipment permits the control to be placed at a distance from the motor.

The advantages of remote control, where one operator controls a large number of machines, or where an explosion hazard exists, or where the plant arrangement does not permit the control to be placed near the motor, scarcely need to be mentioned.

Semi-automatic starting has been developed to meet the need for an inexpensive control that retains the simplicity of induction motor starting, which consists merely of the "starting throw" and the "running throw." The semi-automatic synchronous motor starter includes the standard type of manual compensator. It provides also a small panel containing meters and a rheostat, a field contactor, and a relay that automatically closes the field contactor when the motor is ready to be synchronized. With this equipment the d.c. excitation is automatically cut off when the motor is shut down, thereby protecting the field winding. So far as the operator is concerned, this control reduces the starting of the synchronous motor to the same basis as induction motor starting.

Comparatively few synchronous motor installations involve completely automatic operation, that is, without attendants nearby. Hence, the protective features of the control are ordinarily designed to shut down the motor, in case of trouble, until the operator restarts it.

In the average synchronous motor installation, protection is needed against the following conditions: (1) Overload. (2) Phase failure or single-phase operation. (3) A.c. undervoltage. (4) Loss of excitation. (5) Failure to complete the starting operation.

Overload and undervoltage protection are most important and are found in practically all synchronous motor controllers. Overload, as distinguished from a short circuit, includes any operating condition that may cause a flow of current as high as four to six times normal.

Here the problem is to protect the motor from injury due to overheating and at the same time avoid shutting it down unless absolutely necessary. This involves the use of an overload relay that will follow as closely as possible the heating characteristic of the motor.

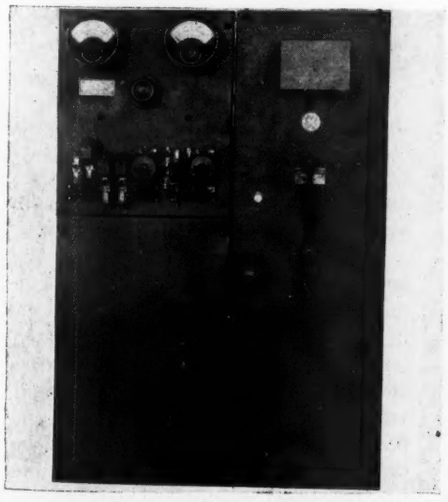
Inverse time relays, usually of the thermal type, are widely used to give this protection. These relays will trip after a long interval at a current slightly above normal, and will trip more rapidly as the overload increases. One form of thermal relay consists of a heating element which carries a current proportional to the load current, and a thermostatic strip which gradually becomes distorted when heated and trips the relay.

The well-designed thermal relay will permit a high, momentary overload, such as occurs with full-voltage starting, and will do this with a continuous setting low enough to protect against a small overload if the latter persists long enough to be serious. As heat is stored in the relay just as it is in the motor, a thermal relay will protect the motor from the effect of too frequent starting. Mechanical relays, such as the dashpot type, generally cannot take account of repeated starting cycles and so merely guard against a single, prolonged overload.

In most cases, control panels for industrial motors are not designed to give short-circuit protection, except where there is a large concentration of power at high voltage, as in a steel mill. Experience indicates that short circuits seldom occur in the conduit wiring between the panel and the motor. Also, short circuits that may occur in the motor windings will generally be limited somewhat by the reactance of part of the stator winding.

To give more adequate protection, a synchronous motor panel or a group of panels is sometimes backed up by a circuit breaker of adequate capacity. Lockout relays or mechanical latches must then be added to the individual panel, to keep the running switches from tripping during the short circuit until the circuit breaker has opened. Where severe short circuits are possible, the individual panels must have a momentary current capacity sufficient to withstand the possible short circuit until the protective breaker has opened.

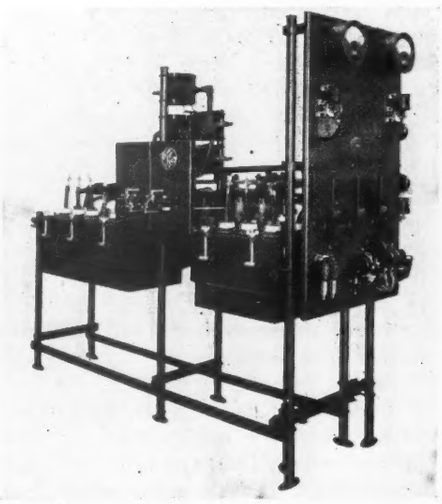
Single-phase or open-phase protection of polyphase motors is usually left to the overload relay. A three-phase motor carrying a given load will draw 73 per cent more current



SEMI-AUTOMATIC starting panel with induction motor compensator for a 500-hp., 2,200-volt synchronous motor.

* * *

REDUCED - VOLTAGE, push - button - operated starter for a 700-hp., 4,000 - volt synchronous motor. The panel includes relays for use with time - delay undervoltage protection.



from the line if a phase opens, causing single-phase operation. This will usually represent a sufficient overload to actuate the overload relay before the motor is injured. For more complete protection, relays may be added that will shut down the motor if an open-phase condition occurs, and prevent restarting under this condition.

Undervoltage protection should always be included in a synchronous motor control. Contactors operated from the a.c. supply will automatically open on failure of voltage. Circuit breakers that are mechanically held are provided with an undervoltage tripping device. Thus undervoltage protection is inherent in all standard control equipment.

Following the development of time-delay undervoltage devices for induction motor starters, there has been a tendency to apply these devices to synchronous motor panels as well, to avoid interruptions of service caused by momentary voltage fluctuations.

Load Interruption and Resynchronizing

Although a time-delay undervoltage device may be used to hold the running switch closed during a voltage dip, or to permit it to reclose upon return of voltage, no advantage will be gained unless the motor is able to accelerate to full speed and resynchronize. Motors of the general-purpose classification, which have high starting and pull-in torques usually can be resynchronized following a momentary interruption of voltage, without removing the load, provided the excitation is removed while the motor is out of step. With such motors, time-delay undervoltage protection can be used to advantage, but the control must also include suitable relays to remove excitation when the motor drops out of step, and re-apply excitation when the motor is again ready to be resynchronized.

Where low-speed synchronous motors of normal design are involved, time-delay undervoltage protection is of little value unless arrangements can be made to remove excitation and also reduce the load when the motor drops out of step, due to fluctuations in line voltage. Where interruptions of service caused by voltage variations are very frequent, some improvement in operation can be obtained by energizing the holding coils of the running switch and the field contactor by direct current taken from the exciter or other source.

This practice will eliminate a certain percentage of the interruptions that are due to voltage dips of very brief duration and would ordinarily cause the control to trip, although the motor might be capable of staying in step.

Failure of Excitation

Loss of excitation voltage will cause the average low-speed synchronous motor to stall unless the load is very light, and will in any case result in a large increase in the line current. A general-purpose motor might continue to carry full load, and would operate as an induction motor with increased current and lagging power factor.

To meet this condition, a d.c. undervoltage relay is sometimes provided, which will shut down the motor on failure of the excitation voltage. However, a properly designed overload relay will shut down the motor before dangerous overheating occurs, and is commonly relied upon to give protection in this case.

If the starting duty of a synchronous motor is severe, it is sometimes well to include a relay that will protect against failure to complete the starting operation. Relays for this purpose are usually time-limit relays, connected to shut down the motor after a definite time interval in case the starting operations have not been completed.

When the line voltage is fairly constant and is close to the rated value, a line ammeter and a field ammeter enable the operator to adjust the excitation of a synchronous motor for unity power factor operation, and thus be assured that the motor will have normal pull-out torque.

Use of Panel Meters

For example, a power factor indicator is of value only when it is desired to know the power factor of the motor itself at various loads. If the user is interested in the effect of the synchronous motor on the power factor of the total load, the power factor indicator should be placed elsewhere on the system. Except in the case of large motors, an a.c. voltmeter is seldom used. If the line voltage is irregular or subject to wide variations, a voltmeter may be used to indicate to the operator the extent to which the starting of the motor is affected by the voltage.

The actual presence of voltage is commonly indicated by a pilot light. The d.c. voltmeter is more frequently found on the synchronous motor panel in cases where this panel is extended to include the control for the exciters. If a spare exciter is available and a change is to be made from one exciter to another without interrupting the operation of the synchronous motor, the exciters must be paralleled. A single d.c. voltmeter may be used to bring both exciters to the same voltage. Where excitation is taken from a separate source, a d.c. voltmeter may be used to indicate the presence of excitation voltage before the motor is started.

The watt-hour meter provides a direct record of the energy consumption of the motor for use in figuring operating costs. Where it is desired to keep account of the energy used per unit of machine output, separate watt-hour meters may be mounted on the individual motor panels. This application facilitates the study of operating conditions with reference to their effect on power consumption, or comparison of two types of drive.

Does Flashing Shorten Lamp Life?

ONE of the controversial questions upon which but little data has been obtained is, "Does a flashing sign reduce the life of the lamp?" Industrial men having sign flashers on their plants will be interested in the results of a series of lamp life tests recently completed at Nela Park, on flashing as compared with continuous burning. The tests were made on 30 selected lamps operating continuously on alternating current, 30 lamps flashing on alternating current, 30 lamps operating continuously on direct current, and 30 lamps operating flashing on direct current. In each of the tests half of the lamps were burned horizontally and half with the base up. Two sizes of lamps were considered: 10-watt, S-14 clear-bulb sign lamps, and 25-watt, A-19 inside-frosted lamps.

The results indicated that except on the a.c. operation of the 10-watt lamps, there was no great reduction of life when the lamps were flashed and in some cases the life was actually longer with intermittent operation.

Of course, the number of hours the lamps would actually be in the sign during its operation would be greater, in the case of flashing, than the rated lamp life. It should also be understood that individual lamps would vary to such an extent that no one particular lamp of a group would be expected to follow exactly the results of this test.

Fig. 1—"Good lighting" is written all over this machine shop. Here 200-watt lamps in Glassteel diffusers give an intensity of 13 foot-candles. The mounting height is 8 ft. 11 in. and the spacing, 8 ft. 10½ in. by 10 ft. 4½ in.

Simple Rules for Laying Out

INDUSTRIAL LIGHTING SYSTEMS

By A. W. KAKILTY

Illuminating Engineer, Benjamin Electric Manufacturing Company, Chicago, Ill.

IN VIEW of the growing attention given by every well-informed plant executive and his staff to the lighting system of the factory, a quick, simple, and practical method of determining the most satisfactory layout for ordinary conditions should prove to be very helpful. Its value will become apparent when additional buildings are planned or remodeling of the old ones is under consideration.

The technical data obtained by illuminating engineers after years of research and practical experience may be condensed into a few short items that furnish a short-cut method of obtaining a practical solution of the majority of factory lighting problems. Of course, when special conditions present themselves or when the problem is quite complex it is well to call upon the lighting specialist who is maintained for such service in all large cities by the central station, or the reflector or lamp manufacturers.

However an attempt will be made in the following paragraphs to condense the standard illuminating design data into simple and compact form, so that any plant man can use these few rules in the planning of future installations and in the provision of adequate wiring. The results will be sufficiently accurate for ordinary industrial work and the process may be applied in the majority of instances.

In the first place, one must consider the location of outlets. This will be governed somewhat by the construction and interior details of the building, but it is well to use a uniform system in which each architectural subdivision or bay will contain the same number of outlets uniformly spaced. Such a layout will accommodate all ordinary arrangements of partitions. Furthermore, any subsequent rearrangement of desks, benches, and machines will be satisfactory from the standpoint of illumination.

Naturally, the number of lighting units per bay must be governed by the spacing distance, and this is, in turn, dependent upon the mounting height of these units. A safe rule for all types of industrial and commercial equipment is to make the maximum permissible spacing one and one-half times the height of the light source above the working plane, as shown in Fig. 2. By "source" is meant the lamp filament, and "working plane"

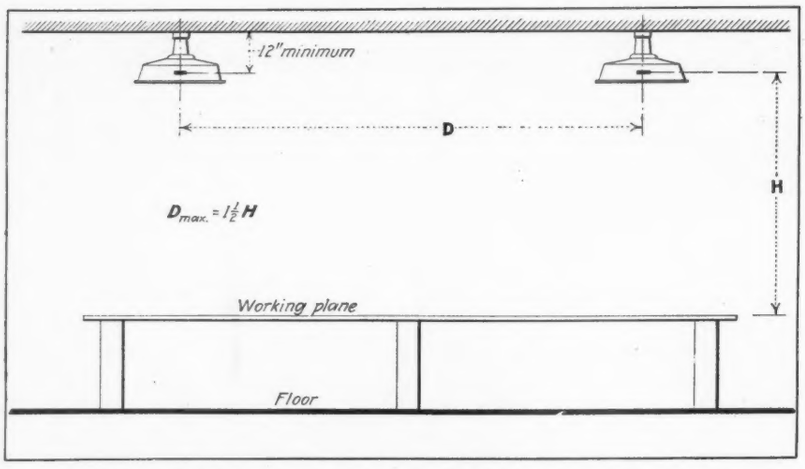


FIG. 2—SPACING between lighting units should never exceed one and one-half times the mounting height above the working plane. If this spacing is materially exceeded, bothersome shadows will be produced.

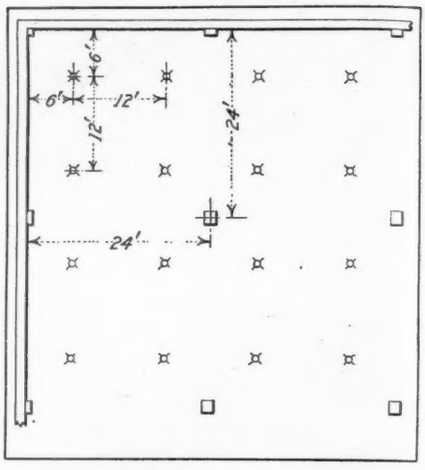


FIG. 3—THIS SHOWS a suitable location of outlets in a factory having 24-ft. bays, with a 15-ft. ceiling.

* * * *

means the table or bench upon which the actual work is being done. Closer spacing than indicated above will result in even more uniform distribution and greater freedom from distracting shadows.

Such a computation of spacing distance is not nearly so complicated as it sounds. For example, suppose we have a 14-ft. ceiling over an area in which most of the men are working on a 3-ft. bench. Placing the unit at the ceiling, it may be assumed that the lamp filament will be at least 1 ft. below the ceiling, or 13 ft. from the floor. Thirteen feet above the floor is 10 ft. above the bench or "work plane," and the maximum spacing is $1\frac{1}{2}$ x 10, or 15 ft. The units may, therefore, be placed on any spacing within 15 ft. and uniform illumination will result.

In a room containing 24-ft. bays the simplest and most satisfactory arrangement would be to place four units evenly spaced in each bay, which would result in a spacing of 12 ft. between the units, as in Fig. 3.

Now that the problem of location is over, the entire layout is half solved. The next question is: How much light is needed? Several pages of tables are usually devoted to this, but the simplest answer is: Enough light to enable the workmen to be cheerful and work at high efficiency. Therefore, the amount required is dependent to a great extent upon the work being carried out.

If, in one department, the men are doing fairly rough work—such as molding or the heaviest sort of machine work — 10 foot-candles are sufficient. For ordinary automatic machine operation provide 15 foot-candles. In the case of extra-close bench and machine work it is necessary to provide from 50 to 100 foot-candles.

For drafting rooms provide at least 25 foot-candles; for ordinary office work at least 15; and in file rooms and storage areas about 6 foot-candles.

"Foot candles" is a measure of the level of illumination just as "volts" is a measure of electrical pressure. The exact definition of the term is of no consequence here, as you will need to keep the values in mind for only a few minutes in order to determine the lamp size.

Do not be mislead into thinking that the above values are excessive. The intensity of illumination outdoors on a sunny day may be 10,000 foot-candles. In that intensity you do not have to do anything more exacting than play golf, and even at that you may not be able to make a good job of it. Surely 25 foot-candles, or one four-hundredth of the outdoor level of illumination, is not too much to give to the workmen whose efficiency means the success of an organization.

Much of the value of a lighting system depends upon the unit chosen. Naturally, you want to obtain the maximum amount of light for the money spent; so you want an efficient unit. To do away with the blinding effects and ultimate eye injury caused by direct and reflected glare, and to secure soft shadows that will not confuse the workmen a unit that is a good diffuser is needed. For ease of replacement and low maintenance a simple, sturdy unit should be chosen.

Not only must the unit chosen be initially efficient, but, to prevent excessive depreciation in both the resulting level of illumination and the capital invested, it should be easy to keep clean, and the reflecting surface should be such that no deterioration will take place over a reasonably long period of time. Special units should likewise be used for specific purposes.

Where local conditions make overhead mounting impossible, elliptical- and symmetrical-angle reflectors are available for lighting from the sides. Dust-tight and vaporproof units are available for dusty and hazardous locations. Again, intensifiers provide a satisfactory method of increasing the illumination over a limited area—say at a drillpress where overhanging portions reduce the illumination resulting from the overhead lighting system.

Numerous such special conditions may require attention, but for the ordinary working areas most often encountered the scientifically-designed, well-made reflectors now available on the market for factory lighting will adequately meet every demand.

To assist in the selection of suitable reflectors, some of the principal types used in industrial work, with their usual applications, are listed below. The reflectors mentioned are shown in Fig. 4.

Glassteel Diffuser—This is used for the very best general illumination of industrial interiors. It is available in sizes suitable for lamps of 200- to 500-watt rating.

R.L.M. Dome—Reflector and lamp manufacturers' standard for general illumination. It effectively illuminates horizontal and vertical surfaces, whereas the angle of cutoff protects the eyes of the workmen. It is available in a number of sizes, to be

used with lamps ranging from 50- to 1,000-watt rating.

Deep Bowl Reflector—This type of reflector gives a high level of illumination on the working plane beneath it and is used where the requirements are such that local lighting must be provided. When correctly mounted and used with the proper size of lamp there is no glare, unless one looks directly at the lamp. This reflector is available in several sizes, to accommodate lamps of 25- to 1,000-watt rating.

Elliptical Angle Reflector—Used when light must come from the side, as in construction shops, with overhead traveling cranes, for lighting sign boards, and so on. Available in a number of sizes for use with lamps of 100- to 1,000-watt rating.

Gas- and Vapor-Proof Unit—Designed for use in locations where hazardous atmospheric conditions prevail, as in powder mills, chemical and paint plants, and the like. Several types and sizes are available, for lamps of 100- to 500-watt sizes.

Dust-Tight Covers — These are made to fit all standard reflectors and are used in places where dust and flying particles may collect on a lamp, producing a fire hazard, or in the reflector, reducing the light output.

Intensifiers—These are designed to project a high-intensity beam under overhanging machinery or at the tool point of a production machine, and can be obtained in sizes suitable for lamps of 60- to 200-watt rating.

From the spacing distance the floor area per outlet is readily obtainable. In the 12 x 12-ft. spacing previously mentioned it is 12 x 12 or 144 sq.ft.; if the spacing is 10 x 12 ft. it is 120 sq.ft., and so on.

Now note the chart shown in Fig. 5. Pick out the spacing in the vertical column. Along the horizontal column pick out the desired number of foot-candles. The horizontal and vertical lines will intersect near one of the cross-cutting curved lines, and the nearest curved line will give the size of lamp that should be used.

Let's try an example. Assume that you have a building with a 12-ft. ceiling, 20 x 24-ft. bays, and that the men are doing fairly fine assembly work on benches 3 ft. high. Now, if the unit were placed at the ceiling the source of the light could not be more than 11 ft. above the floor, or 8 ft. above the bench. This permits 1½ x 8, or a 12-ft. spacing. However, we desire a uniform layout; so we will probably decide to put four units per bay on a 10 x 12-ft. spacing, which is 120 sq.ft. per outlet. The men are doing rather fine work; so they need at least 20 foot-candles, and as their work is fairly clean and we desire a good-looking room, we will probably use the glassteel diffuser.

Looking along the vertical column of the chart we find 120 and on the horizontal line we find 20. These two lines cross between the 300- and 500-watt lamp sizes. Moving about a little we find that the 300-watt size at that spacing will give 17 foot-candles, whereas the 500-watt lamp will give 30 foot-candles. These values are depreciated; that is, allowance has been made for ordinary ageing of the lamp and a slight collection of dirt.

So we will probably use the 300-watt lamp and take the 17 foot-candles depreciated. However, to accommodate a probable later demand for higher intensity each socket should be wired for at least 500 watts.

To summarize:

1. Spacing of lighting units should not exceed 1½ times the mounting height.
2. Minimum intensities:
   - Casting or heavy work—10 foot-candles.
   - Ordinary work, automatic machines, etc. — 15 foot-candles.
   - Extra-fine work—50 to 100 foot-candles.
   - Drafting rooms — 25 foot-candles.
   - Office work—15 foot-candles.
   - File and Storage areas—6 foot-candles.
3. Use an efficient, well-designed unit.
4. Determine lamp size from the accompanying chart.

The foregoing procedure is very simple, but it can be used to solve all ordinary problems very satisfactorily.

One thing should be remembered. When the new installation is in place don't forget to keep it clean. Dirt can cause a loss of 50 per cent or more of your light. Clean the units thoroughly with soap and water at least once a month.

* * * *

FIG. 4—SOME of the types of reflecting equipment commonly used in industrial illumination. The general applications of these units are explained in the text.

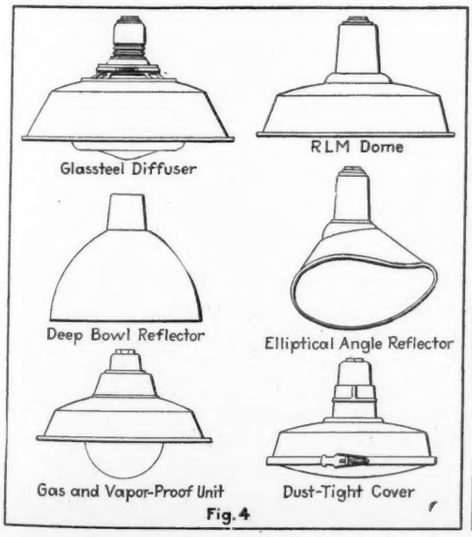


Fig. 4

* * * *

FIG. 5—THE SIZE of lamp needed for different areas can be determined from this chart. This chart has been computed on the basis of fairly large areas and ordinary dirt conditions. For small areas or very dirty interiors the intensity in foot-candles will be somewhat less.

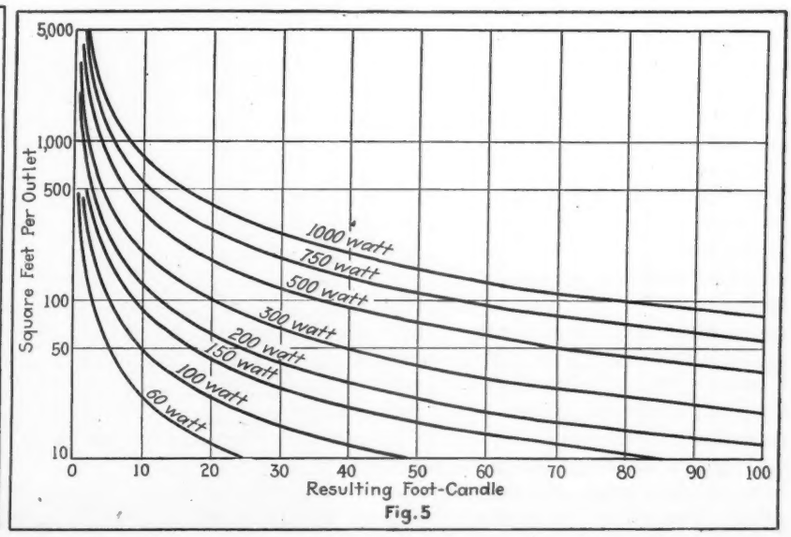


Fig. 5

Maintenance PAINTING *on an Engineering Basis*

By ROY C. SHEELER

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Prescription Paint Service
E. I. du Pont de Nemours & Company
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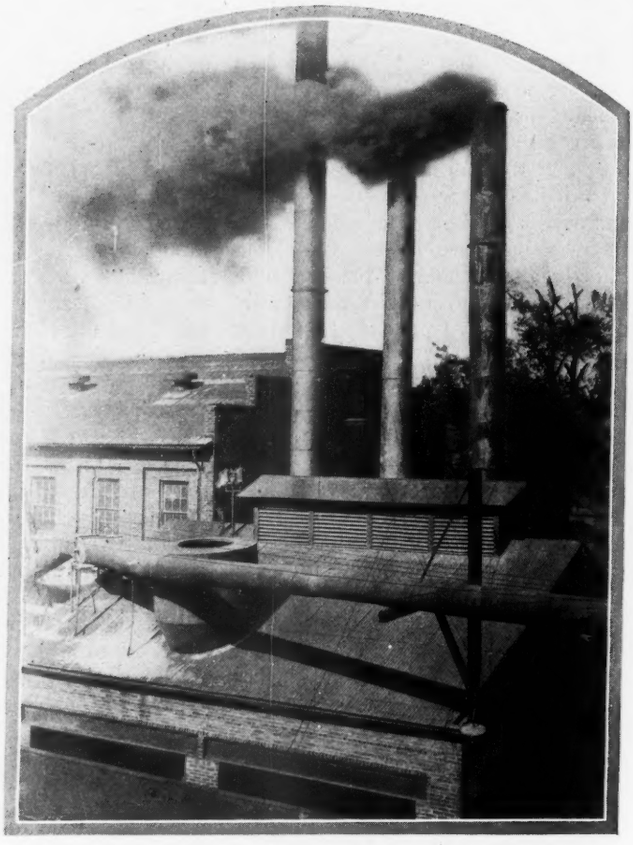


To avoid early replacement, all exposed sheet metal work must be adequately protected from the weather and other corrosive influences.

* * * *

MOST industrial plants today have at least one engineer; many have numbers of them, each of whom is an expert in some line of plant operation. He is an expert for the reason that he has given a large amount of study, effort, and time to the analysis of all the problems that confront him in his daily toil. He has eliminated guesswork and his reasoning is based upon scientific facts. It is also backed by experience, and not simply theory. This applies today to practically all phases of plant operation.

There was a time when this was not the case. Rule-of-thumb methods prevailed. Because a certain method had been followed in times past was sufficient cause for its continuance, with very little thought given towards improvement. Or, if improvement was attempted, it was done on someone's theory, without having much in the way of facts to support it. In other words, it was nearly all pioneering, and the lessons learned from this method of plant operation were in many cases unnecessarily costly.

This condition applied to the problems of plant maintenance along with other operating problems. For example, no definite schedule of preservative treatment was followed. Exterior surfaces were allowed to rot and decay; interiors became dirty, dusty and dingy, with consequent loss of light-reflecting power and all the other attendant ills. No one thought much about the effect of depressing surroundings on morale, nor their effect upon the class of work done in the plant. More often than not, when painting was done, the type of product used for each surface was not chosen with any great amount of care, for "paint was paint"!

Today all this is changed. The plant manager knows the value of keeping outside and inside surfaces spick and span, and in good conditions. He knows that it does not pay to allow wood to rot, or to permit the canker of rust and corrosion to eat its way into expensive steel and metal surfaces of plant structures and equipment, for in all cases replacement is expensive. Lumber costs are high; also, it is difficult to obtain well-seasoned stock. Steel structures and equipment parts are costly. Furthermore, if replacement is made, the new surfaces must be painted, anyway; otherwise it is not worth while to replace the old parts. So there is nothing gained by ignoring the facts in the case.

In the modern plant of today the responsibility for adequate plant maintenance is placed either in the hands of one man or a group of men who constitute a committee having this work in charge. They have a definite painting program, with a record of each major surface in and about the plant. Many concerns keep this record by buildings and rooms, listing the surface painted, the date of painting, the kind of paint used, how applied, and so on. In fact, a full history of the case is available at all times, including the cost of the material, labor cost, weather conditions, and all other facts of importance. The value of such a record as this is self-evident. It shows at a glance whether the paint investment for that unit or building was made wisely. It permits of comparisons of costs from year to year. If the work was done by brushing one time and by spray application the next time, the record gives one a clear picture of cost comparisons between the two methods. Everyone is looking today for the best and most durable results at the

lowest cost. But, in the case of paint, this cost must be calculated only on the basis of *the cost per year of service,* and not by the cost per gallon at the time of purchase. A paint that cost $4.50 per gal. and gave five years' good protection is far more economical than one that costs $2.50 per gal. and lasted only one year. In the long run the product that will make repainting periods come farthest apart, consistent with adequate protection and good housekeeping, is the cheapest, regardless of the price per gallon.

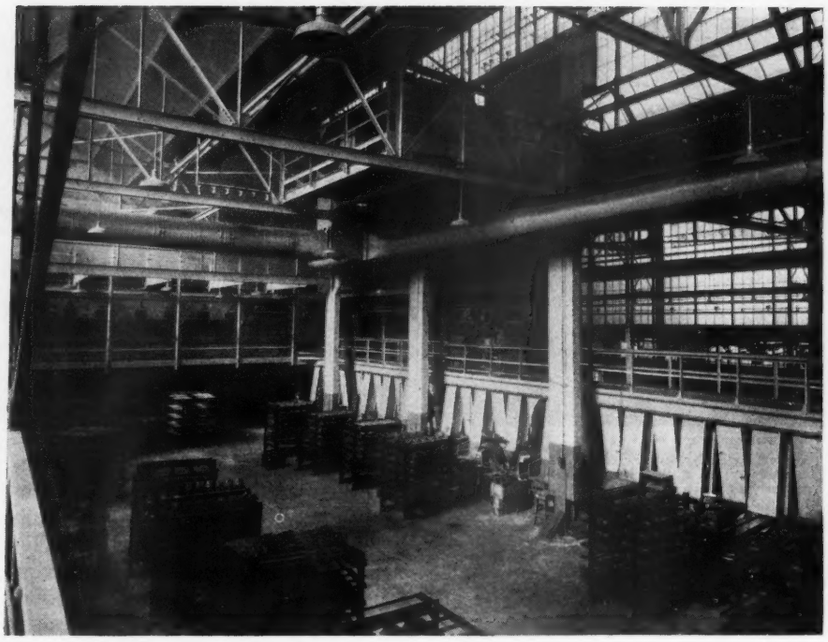
Now, how is the plant manager to put his operations from the maintenance standpoint on an engineering basis? This will depend upon the manner in which he desires his engineer to function. It is not to be supposed that every plant engineer will become a walking encyclopedia of paint information. Painting is only one of the many details for which he is held responsible.

The first thing to do is to make a careful study of plant conditions. Go over each building, inside and out, and note the following points about all surfaces that are or should be painted:

Date last painted, if possible to obtain it.
Kind and color of paint used.
How applied.
Any unusual conditions under which the paint must serve.
Present condition of the surface.

* * * *

NEGLECT of painting schedules makes a plant look like this.



EVEN a foundry can be given a bright and cheerful appearance by the proper use of good paint.

* * * *

With these data in hand it is a simple matter to lay out a schedule of work that should be done. For the most part, exterior work is of the greatest importance, because unless they are given adequate protection, it does not take long for surfaces to decay to the point of replacement. Weather conditions are a very important factor in exterior painting; therefore, such work must be scheduled so that it can be done in dry weather and under conditions that will insure satisfactory results.

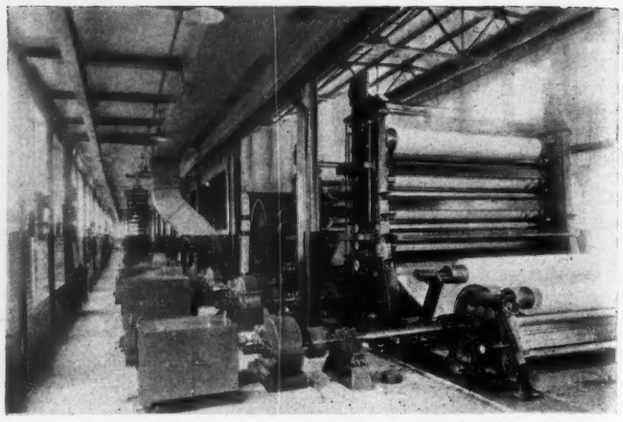
With a knowledge of the present condition of the surface, it will also be possible to determine the character and extent of the preparatory work that will be necessary before the paint can be applied. *This is the most important part of the whole painting program.* It is also usually the part that is the easiest to slight or do only half-heartedly. No matter how well the product selected may be suited for the work to be done, unless the surface is in the proper condition to receive the new coat it had better not be applied at all.

Next in importance is the product to be used. This will also depend upon several factors. Here the experience of the engineer will be valuable. For example, he may have a record of the manner in which a certain product performed elsewhere under similar circumstances. This is not an infallible guide, but it is a starting point, at least. Again, he may have made more or less of study of paint technique and be somewhat an authority on it. He may also rely upon the judgment of the responsible paint and varnish makers, who are in a position to offer suggestions and recommendations which he knows can be depended upon to meet the peculiar conditions that exist in this particular plant.

Every plant engineer is prone to look upon his protection problems as being different from those of any other plant and for that reason requiring a special method of handling. Although operating and atmospheric conditions do vary, there are certain common factors that have an impor-

WELL-PAINTED, white ceiling and walls, with a dark dado, make this shop pleasant to work in, and easy to light.

* * * *



PAINTING machinery a light color greatly improves the appearance of work rooms.

* * * *

tant bearing upon the proper choice of product. When these factors are once recognized, the selection of the product is not particularly difficult.

For example, color enters into the picture, in the case of both inside and outside work. Naturally, the exterior of the plant must be attractive looking. Therefore, the color and nature of the adjacent surfaces must be considered, so that when the painting is done there will not be a clash of color, but a harmonious effect.

When it comes to interior work, there are a number of important factors that govern the choice of product. Here the inspection should bring to light those surfaces that show disintegration, dinginess, dirt accumulation, and rust. Of prime importance is a light-reflecting finish, especially in those plants that depend upon electricity for lighting purposes. The finish used need not be white, particularly in plants where the manufacturing processes make it exceedingly difficult for a white paint to keep its color long enough to warrant application. This fact may as well be recognized and handled accordingly.

Some industrial plants purchase an interior finish of recognized durability, but tinted off to an ivory or cream color. Their engineers have found that a white will soon discolor under the atmospheric conditions, and that this discoloration is likely not to be uniform, but to run in streaks. The use of a tinted product insures a uniform appearance and at the same time permits of maximum light reflection.

Many plants have found in aluminum paint a means of protection plus a comparatively efficient light-reflecting surface. This material gives a finish that does not retain dust and dirt, but permits of easy cleaning, when necessary, with satisfactory results.

In most plants the practice of painting the lower portion or dado of walls a darker shade, is followed. This is a good plan, because it insures an appearance of cleanliness by producing a surface that does not readily show the results of physical contact. A hard-drying finish should be used so that the surface may be able to resist physical contact to the maximum degree.

Machinery is coming into the painting schedule more and more every year. Why have machines in a black or other dark shade when they could just as well be finished in a gray, aluminum, or other *light* color, with consequent improvement in appearance as well as in the ability to reflect a portion of light, and thus make better workmanship possible? Machinery and equipment that is kept well painted in some of the lighter shades certainly has a great deal to do with the quality of the workmanship and the morale of the employees. The up-to-date plant engineer is alive to the possibilities here and is acting accordingly.

If your maintenance program has not been conducted on such a platform in the past, there is no better time than *now* to begin it. Summer is here with all its attendant duties. Good painting weather is worth taking advantage of. As a matter of fact, there is usually much inside work that might be done almost any time. If you have a slack season put some of your employees at work slinging a paint brush, and thus have your plant in better condition for the busy season when it begins.

Some plants follow the plan of putting a crew to work immediately after the Saturday shutdown. With workmen under the supervision of a competent foreman, they can do a vast amount of work, even though many of them are not familiar with painting technique.

Many plants could well afford to invest in a portable spray-painting machine. With such equipment four or five times the amount of surface can be covered that is possible when the paint is applied by brush, and the work done well, too. The initial investment in a dependable machine is not very heavy today and it surely is a paying proposition if there is a large amount of interior painting to be done, particularly on broad surfaces. Furthermore, with the training and coaching that are given by the representative of the maker, it does not take long for a workman who is not at all familiar with the latest method of paint application to become sufficiently acquainted with it to do creditable work.

Each plant engineer can best settle the painting period to meet his exact needs. The summer vacation period is a good time to renovate the plant and to do both inside and outside work. But, in any event, make it a point to have some set program for maintenance painting. Then, take the paint manufacturer into your confidence and allow him to make his recommendations, especially under unusual or severe conditions. In the long run your painting costs will be lowered and the surfaces given better protection than ever before.

Someone has said that we pay for paint whether we use it or not. As a matter of fact, we pay *more* for the paint we don't use. There is a much more general acceptance of that fact in industrial maintenance practice today than there was a decade or so ago. The forces of rust, corrosion and decay are always on the job, and in painting as in all other maintenance work, the keynote is prevention of trouble before it starts.

A. C. ROE *explains how*

Modern Coils *and* Windings

can replace the old shove-through concentric type

A PREVIOUS article, in the June issue, dealt with concentric chain hand windings; it was pointed out that these were not only difficult to install, but extremely difficult to insulate thoroughly and treat, making the hand winding suitable for low-voltage work only.

These disadvantages lead to the development of the shove-through type of concentric chain winding, for which the coils could be made up on a mold or on special benders.

With the shove-through type of winding, only one end of the coil can be made to its final shape. The wire for the slot section, and the opposite end, must be kept absolutely straight and compact, so that it can be pushed through the slot from one end of the stator.

This type of winding can easily be insulated and treated for high-voltage operation, as the wires can be treated and insulation applied between turns, layers or sections. Also, the formed end of the coil and the slot sections can be completely insulated before installing the coils in the machine.

Fig. 1 shows a bent coil of the shove-through, concentric-chain-winding type. Note the closed and formed end, and that the coil is completely insulated and treated. The short length of wire at the open end is formed after the coils are in place; so this section of the coil is not insulated until later by the armature winder. It will be noticed in Fig. 1 that the correct bevel of the slot sections is maintained. This is very important, as any error in the bevel would cause the coils to bind when shoving them through the slots.

Fig. 2 shows the bent ends of a group of three bent coils; these coils are wound with a heavy copper strap conductor. This illustration shows the method of making the connections between coils of the group, and also the type of connector used for the pole-phase group connections, or jumpers, as they are termed.

With the type of coil shown in Fig. 1, the method of installing is to shove the bent coils through first, from one side only. The open ends are then formed, using forming blocks similar to those shown in the previous article. Next, the straight coils are pushed through from the opposite side and their open ends formed.

With some windings, a special group is required, half of the coils being straight, the other half bent and formed by the winder. Such a special group, when required, would be the last one installed.

Figs. 3 and 4 show another method of installing a varnish-treated, shove-through type of coil.

The coils for the winding shown in Fig. 3 are made the same shape as that shown in Fig. 1, but instead of pushing the open ends through the slots and then forming the rear end, a set of blocks and guides are made for forming the open end. After the coil is put in place, the ends are bent down and insulated

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FIG. 1—CONCENTRIC-CHAIN, shove-through winding coil with one end formed and the other open. This coil has been given the gum-impregnation, vacuum treatment.

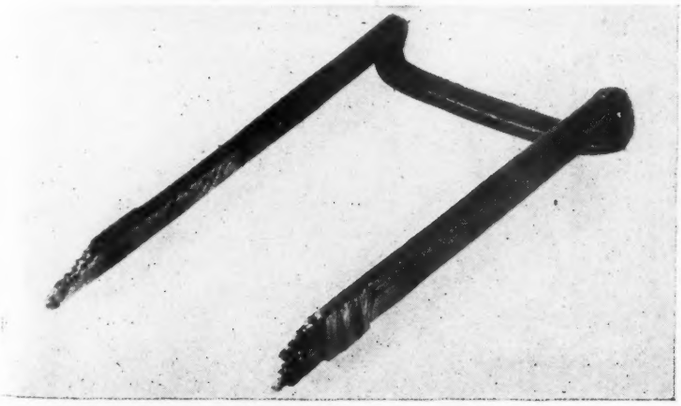

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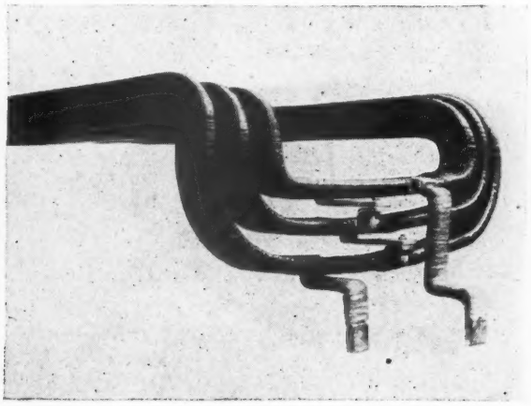
FIG. 2—GROUP OF THREE bent coils of a concentric-chain, shove-through winding. Note the method of making connections between the coils of the group, and the connections for the pole phase groups.



properly before laying the next coil.

The above discussion covers the two general methods of installing shove-through coils, but the construction of the coils has not been covered. Therefore, a brief description of the methods of making coils of the shove-through type will be given.

One general method is used to form the coils; that is, the wire is cut into suitable lengths and then formed around a special block or bending fixture. When forming the wire must be kept free from kinks, or sharp bends, and is held together at various points with cord or tape bands. After forming, the turns or layers are reinforced at all sharp bends with tape or strips of insulating material.

The next step is to provide means of stiffening the slot sections; that is accomplished by the following method: The wires are pulled up and held square and in tight formation by a layer of cotton tape, heavy tape being used for large coils, where considerable tension is required to pull the wires and hold them in place.

On top of this binding tape, a layer of open-weave gauze tape is applied, edge-lapped. This is termed a "stripping tape," as its only function is to provide a medium for removing the lumps of gum after impregnation and thus give the treated coil a smooth finish.

After applying the stripping tape, the coils are impregnated with a gum compound, using the vacuum and pressure method. When the coils are removed from the tank and have cooled, the stripping tape is removed.

The next step is to press the coils along the slot sections to smooth out all unevenness and force the wires together into a compact unit; at the same time the correct bevel and spread or pitch of the coil must be maintained. This is accomplished by using steam presses, such as shown in Fig. 5. These presses consist of two L-shaped arms that can be rotated to obtain the correct bevel and adjusted to suit the width or pitch of the coil. Thus, both slot sections of the coil are pressed at once, insuring the correct bevel and pitch.

Use of this method results in a well-treated and rigid coil and is the process employed for all large machines and high-voltage coils.

The second method of obtaining a rigid slot section is carried out as follows: A layer of cotton tape is applied as described above. The cotton covering on the wire, throughout the slot sections only, is well filled with liquid Bakelite varnish, and then hot pressed in the same manner as before.

Then, after pressing, the coils are dipped and baked, using a high-grade, black, plastic varnish, the number of dips and bakes varying according to the operating voltage, operating conditions, and size of the apparatus.

From this point on, the operations are the same and consist of applying a mica and fishpaper wrapper to the slot sections, and a number of layers of treated-cloth tape to the rear or formed ends, the complete coil being covered with a layer of cotton tape.

The number of turns of the slot wrapper and number of layers of treated-cloth tape are varied to suit the operating voltage.

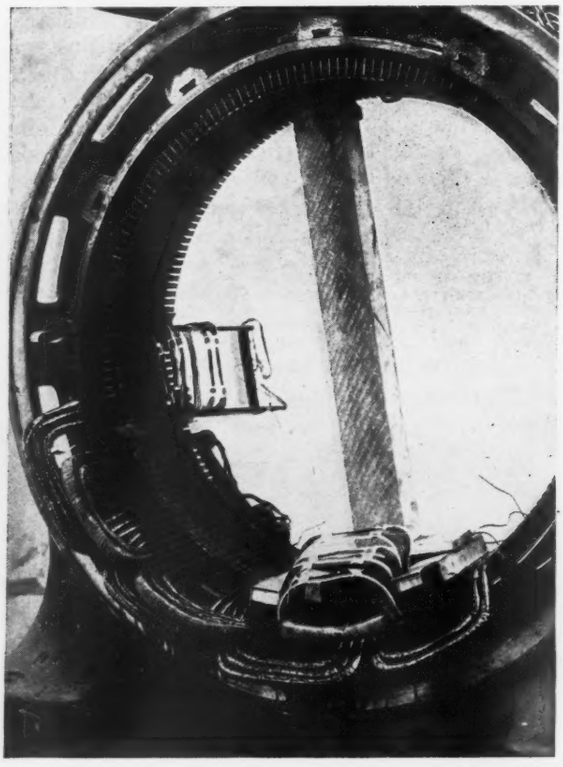
In some cases where room is scarce a special mica wrapper, termed a "hot-pressing wrapper" is used, to make it possible to press the coils down a second time after wrapping. This brings them down to size and makes a compact unit, free from air pockets or soft spots.

The coils are then given a treatment in baking varnish, the number of dips and bakes depending on the operating conditions and voltage, size of the apparatus, and so on.

The shove-through winding, using the concentric-chain type of coil requires careful attention to details, not only during the coil manufacturing process, but throughout the installation of the winding as well.

The foregoing covers the types of coils and the method of installing them. It will now be in order to cite some methods that can be employed to change the shove-through concentric chain winding to up-to-date types of coils and windings.

When the voltage of the original winding does not exceed 600, the

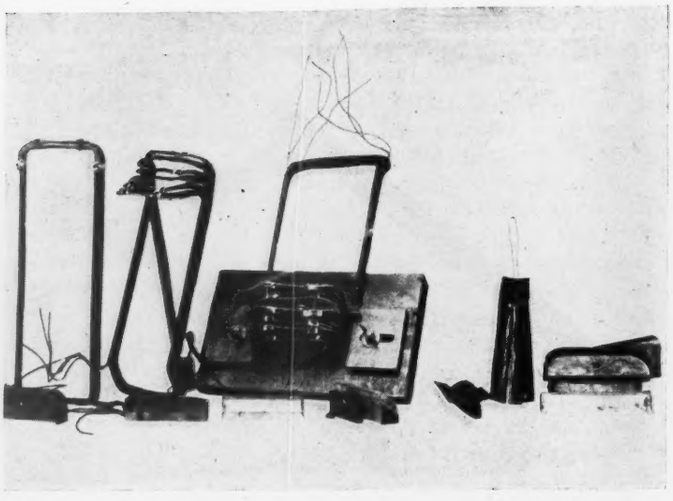


* * * *

FIG. 3—THE OPEN ENDS of the coils of shove-through, concentric-chain windings may be formed before the coils are installed. The blocks used for this purpose are shown in Fig. 4. When this procedure is followed the ends of each coil are bent down and insulated before the next coil is put in.

* * * *

FIG. 4—FORMING BLOCKS used to close the ends of varnished, shove-through, concentric coils.



two - layer, mush - pulled, diamond-shaped-coil type of winding can be employed. If the voltage is between 600 and 2,500 volts a special, layer-wound, pulled-coil, threaded-in type of winding can be used. Both of these types of coils were discussed in a preceding article.

However, the shove-through windings are made with various types of conductors and turns per coil, and from the following types of windings one can be selected to suit any condition:

1. Mush puller.
2. Layer-wound, threaded-in wire or ribbon.
3. Strap copper threaded in, edge wound.
4. Shove-through, one-turn, one-piece or two-piece, strap copper coils.
5. Wire-wound section coils, two-layer, pulled type.

As these are up-to-date types of coils, they will be covered in detail later in this series.

There are some cases that necessitate increasing the width of the slot opening, to accommodate a later and improved type of winding. However, this should not be done without first checking the original design records and then studying the new operating conditions, to determine what effect opening the slot will have on the power factor, heating, and efficiency of the apparatus that is being repaired or rebuilt.

Operation of Reverse-Phase Relays

THE reverse-phase relay usually consists of a small polyphase motor and a contact which normally is in the open position. The small polyphase motor has its windings connected in shunt to the power wires leading to the controller. When the phase rotation is in the proper direction the motor exerts a torque which overcomes a spring pressure or weight and closes the relay contacts. The control circuit passes through these relay contacts in the same way it passes through the contacts of an overload relay.

Should the phase rotation be reversed the torque of the small polyphase motor in the relay will be reversed and the relay contacts opened. This opens the contactors on the controller and disconnects the main motor from the source of power.

The reverse-phase relay also opens if there is a failure of voltage on any of the power wires, except when the main motor is running. The main motor when it is running at full speed acts as a phase transformer and maintains a polyphase voltage across the terminals of the relay even when the main motor itself is receiving single-phase power.

If the main motor is operating an elevator or some device that runs for only a short time it may continue to operate single phase until the trip or cycle is completed. When the main motor is stopped and only single-phase power is available the reverse-phase relay motor looses its torque and opens the relay contacts.

Another type of reverse-phase relay consists of a coil and plunger magnet. The winding of this magnet is divided into as many equal sections as there are phases in the circuit, for instance, a three-phase relay would have three separate sections in the coil; one connected to each phase. These coils are so connected that they exert their maximum pull on the plunger when the proper phase relationship exists between the coils. If one phase is reversed, the pull on the plunger is reduced and it drops, opening the control circuit contacts.

There are a variety of different reverse-phase relays offered to the trade, some of which maintain the contacts closed when the phase rotation is correct.

Reverse-phase relays are ordinarily applied to elevator installations and sometimes to pumps where the operation of the pump in the reverse direction would be undesirable.

* * * *

FIG. 5—THESE STEAM PRESSES are used to compress and smooth the slot sections of the coils of shove-through windings.

INDUSTRIAL ENGINEERING
with which is consolidated
INDUSTRY ILLUSTRATED
Electrical, Mechanical and Plant Service in Industry
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Do Your Own Standardizing

ANY operating executive who does not have his fingers on the storeroom pulse is failing to take advantage of the potential possibilities in equipment standardization that means much to his plant and industry as a whole. Usually, too much executive authority is exercised in disapproving, without investigation, requisitions for legitimate stores material. Consequently, succeeding requests are necessarily padded to make up the difference. In some cases it is this difference that fills the shelves with obsolete parts, yet in others it is a combination of causes. Some manufacturers make standard parts over a wider range than others, necessitating a greater number of items for stock. Failure to correctly tabulate all stock items of a class of material that may be interchangeable with minor adjustments add further to the chaos, and so on.

Inasmuch as universal standardization cannot be accomplished over night, it is undeniably certain that a little pioneering by individual plants in standardizing their own equipment will at least give their storeroom relief from an excess of either unused or obsolete parts.

Of the many methods suggested for the acceleration of the equipment standardization movement, the intelligent selection of equipment has the greatest potentialities, and one particular company has taken advantage of this fact. In order to keep their inventory as low as possible, yet consistent with safety they were forced to do their own standardization.

They started in the storehouse, so a few examples of what was done may suggest methods which may be used by others. It was found that almost every crane used different sizes of bridge or trolley track wheels which differed only by fractions of an inch on some one or two dimensions. Tabulating the sizes showed that most of the differences were in the hub and bore dimensions. As a result a few sizes were selected according to wheel diameters and flange sizes with the maximum hub dimensions and minimum bore. Now any wheel in stock can be machined to fit any crane using a wheel of the particular diameter.

Crane cable was ordered in reels and cut off as desired. This always left a length just too short to use. A study of the cables needed for the different cranes indicated that a few standard lengths could be ordered cut to length, and without waste for the same price. Likewise a study of carbon brushes led to the elimination of about 200 sizes, grades and shunt lengths. A table shows what size and grade on hand are to be used in each particular place.

All this tends to show that with intelligent selection of equipment it is possible to carry lower stock and to turn over the inventory of spare parts several times a year without risking serious trouble by decreasing to a dangerous point the minimum quantities carried. Consequently, it is safer, consistent, and more economical to have a fewer number of items rather than smaller quantities of each item. Sense in equipment selection is worth dollars in unused spare parts.

Have You Made Up Your Schedule of Summer Work?

THE slackening of production that comes in many industries during the summer months gives operating and maintenance men what should be a welcome opportunity to put their plants in shipshape order for the increased activity later on in the year.

In warm weather it is much easier, and oftentimes less costly, to handle the variety of outdoor jobs that need attention. Thus, summer is obviously the best time for outdoor, as well as indoor, painting. It is also the best time to go over roofs, gutters and all outside surfaces and make necessary repairs or replacements.

Examine carefully all overhead distribution lines, fire alarm, telephone, and other circuits to make sure that insulators and supports are in good condition and able to withstand the loads that wind, sleet and snow will impose on them a few months from now. If new work of any kind is being planned, get it started as soon as possible.

Within the plant, the long hours of summer sunshine give ample opportunity for overhauling, or making alterations or additions to the lighting system, without interfering with production.

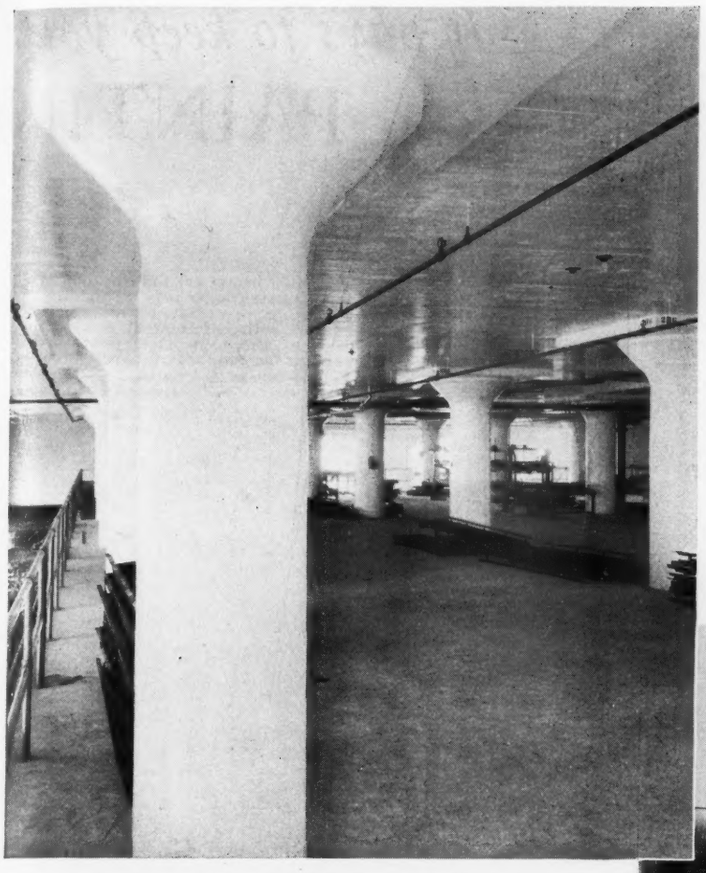
An occasional thoroughgoing inspection and overhauling are practically a necessity with many kinds of equipment. Again such work can generally be done to better advantage during the summer than at any other time.

A little careful planning will make it possible to carry on these and a host of similar activities during the summer with the minimum of interference to production, as well as golf or fishing, schedules. Now the work can be done easily and at minimum cost, and you will have the satisfaction of knowing that your plant is fully prepared to meet any demands placed on it later.

It pays to keep your

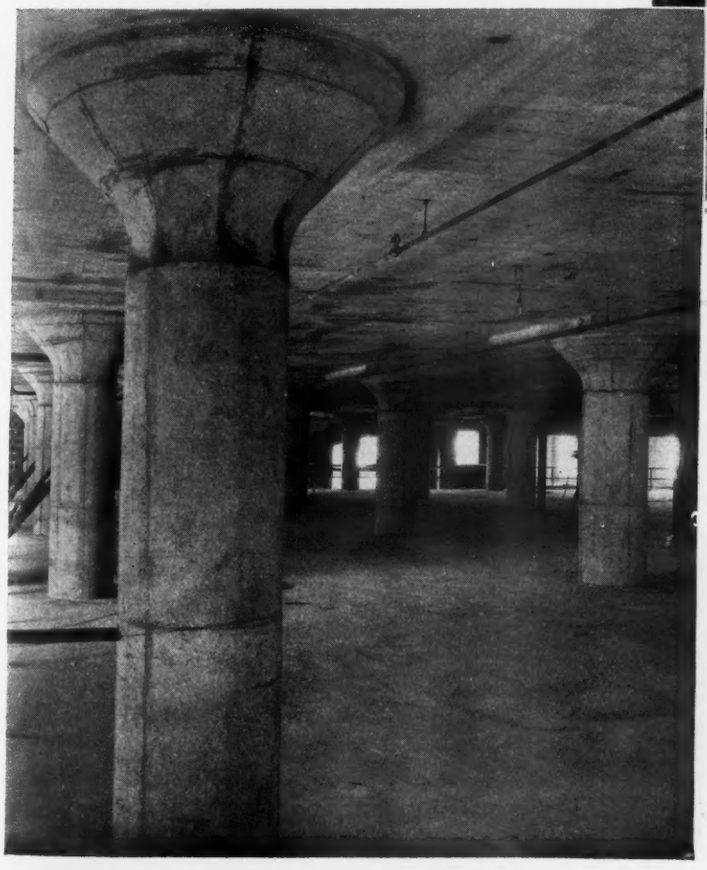
PAINTING PROGRAM

up-to-date



The above view shows rather strikingly, when contrasted with the one below, what good painting can do to increase the natural illumination.

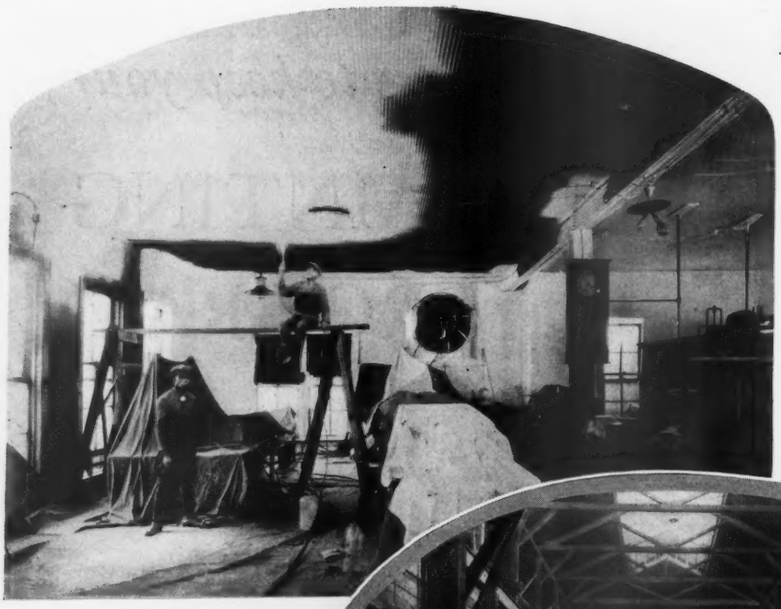
The portable spray equipment takes most of the drudgery out of this work. Note the respirator worn by the operator; a device which protects him from the fumes inseparable from paint spraying.



THE things we take for granted are often the very ones on which we need to check up every little while. To paraphrase a popular song, take painting, for instance. We will admit without argument that proper painting costs only a fraction of what it saves in early depreciation of plant and equipment, to say nothing of its effect on lighting, morale, and a number of other things.

These pages are intended as a gentle reminder that good painting weather is here; that if you haven't adopted a commonsense painting program, it would be worth thinking about; and, if you already have, it might pay to check up on it.

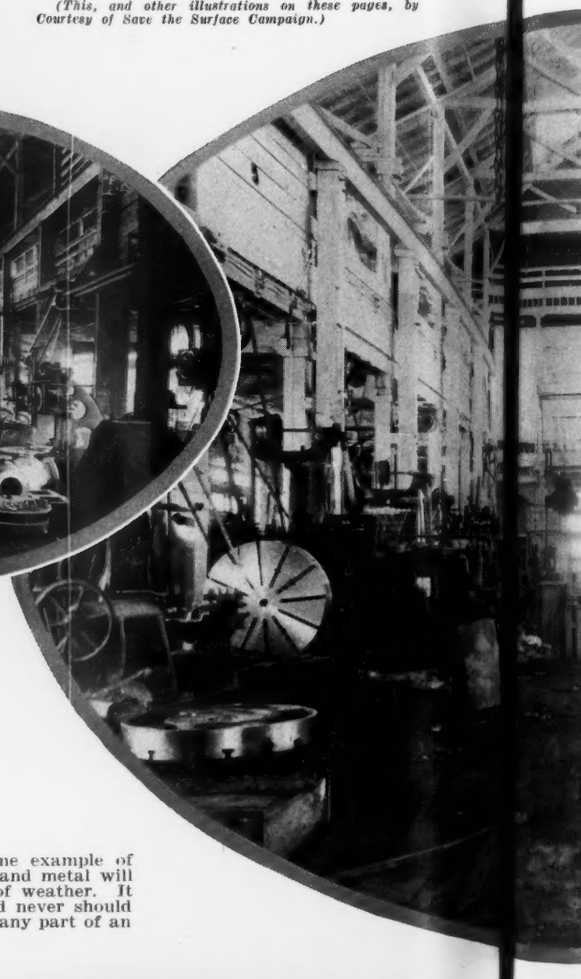
It pays to keep your PAINTING PL



Paint spraying permits overnight or week-end accomplishment of such jobs as this. Note, here, the difference in natural light from the painted and unpainted portions.

In the two ovals below are shown "before and after" photographs of a foundry which, by using one coat of aluminum paint, secured both better light and better morale; at the same time providing real protection for the structural surfaces.

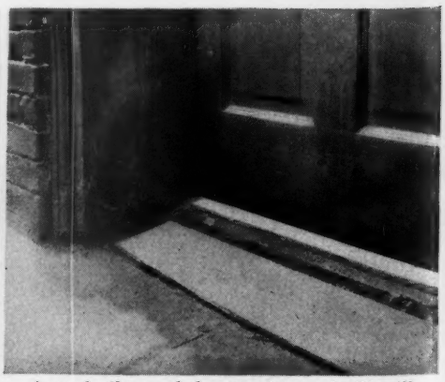
(This, and other illustrations on these pages, by Courtesy of Save the Surface Campaign.)



This is a rather extreme example of what unprotected wood and metal will do under the influence of weather. It is what can happen, and never should be allowed to happen to any part of an industrial plant.

Here, a board runway was laid directly on the ground. Paint would have saved the cost of replacement for a long, long time.

Wood and iron simply will not resist the weather as brick does; that is why this happened.

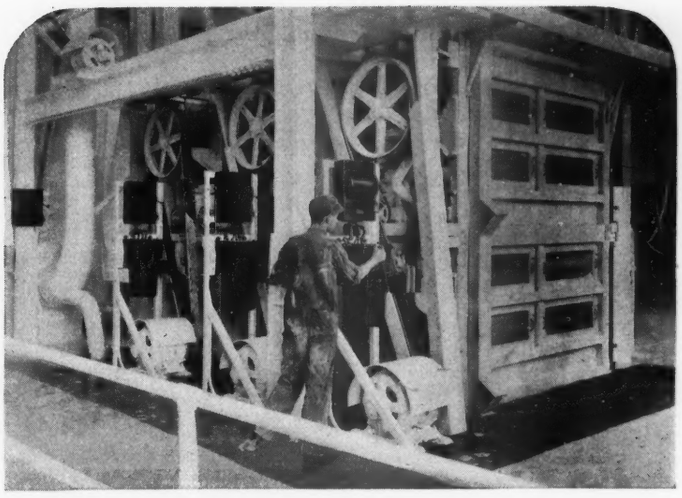


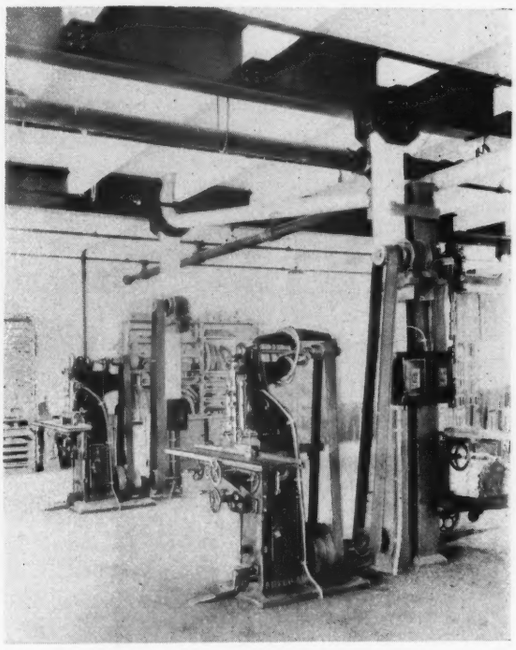
A perfectly good door casing and sill will have to be replaced; whereas proper paint protection would have prevented such a condition.

G PROGRAM

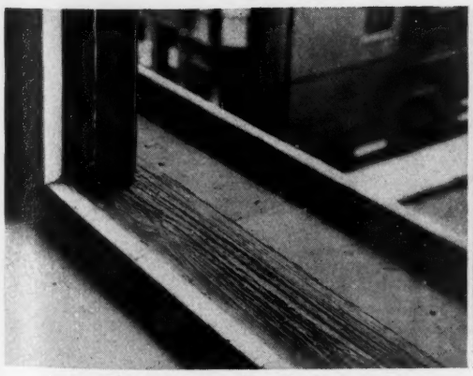
up-to-date

The use of light colors for motors and machinery, as well as for ceilings and walls, has many advantages and is on the increase. It promotes safety, adds to the natural light, and promotes better maintenance and cleanliness.



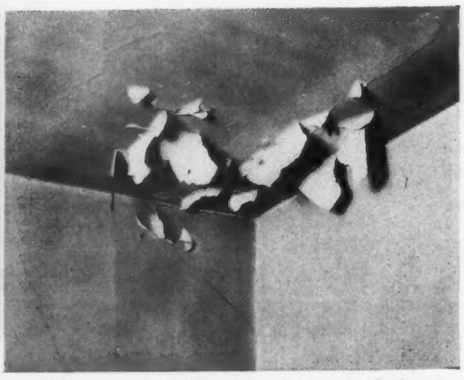


Often an old, cheerless building can be made to outrival the most up-to-date mill, merely by the judicious use of paint.



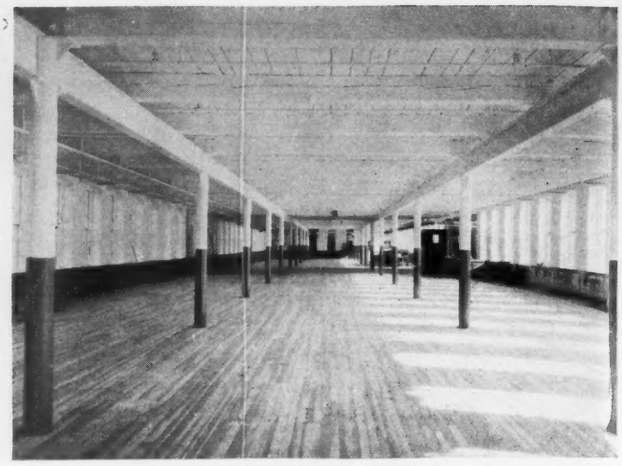
A wooden window sill which has been allowed to go without paint protection; as a result, the weather enemy is going to cause trouble below the sill.

Here is a job that is going to be done right—by proper surface preparation.



When paint acts like this, it pays to find out the cause and cure it, before applying a fresh coat; otherwise it will keep right on happening, no matter how often it is painted.

Here is a typical "old-style" factory; the accepted thing, only a few years ago, and not by any means obsolete today. But it can be improved.

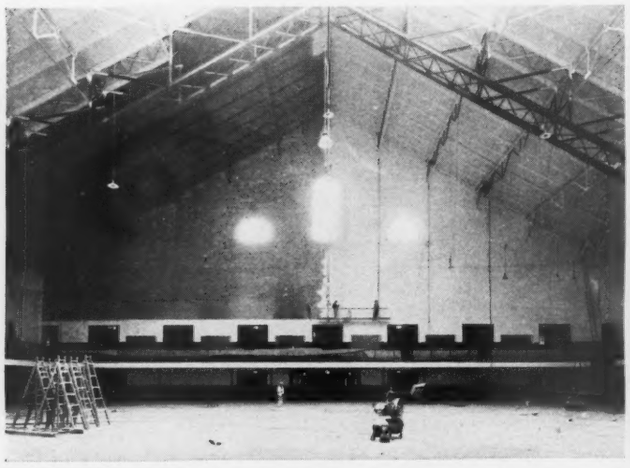


Even without the alteration of supporting columns, there would be a great deal of difference between this and the picture at the left; a difference due solely to paint.

On structural work, paint protection should go hand in hand with erection; otherwise rust gets in its work, later, in inaccessible places.

IN PLANNING an up-to-date painting program for your plant, keep in mind the fact that a little intensive study now will save hours of labor, minimize interruptions to normal routine, and prevent costly mistakes and neglect. The time to plan and to put the plan in operation, is now. By establishing a schedule based upon inspection and study of individual requirements, painting can be—as it should be—made a matter of regular routine.

It costs less to paint, than to neglect it. The labor cost is many times the cost of the paint itself; so take advantage of modern equipment wherever possible. Last, but not least, learn to appraise the cost of paint, not by the dollars per gallon, but by the dollars per year of satisfactory service per square yard.

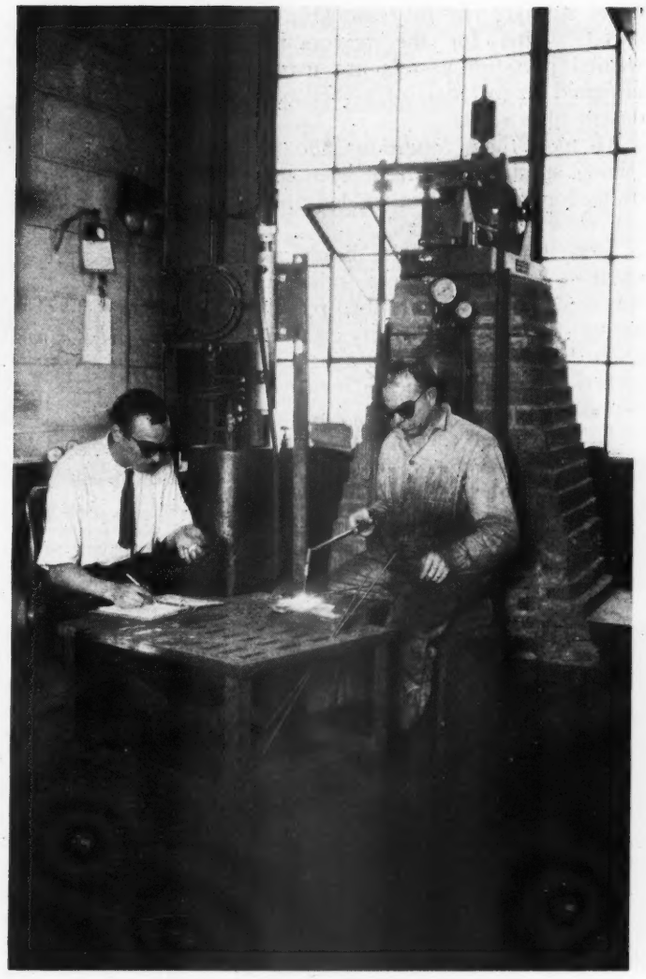


Where surfaces as immense as this are involved, the spray method is the obvious solution. Note, again, the transformation effected by paint alone.

After showing so many cases of what paint can do, we couldn't resist adding one example of what neglect of paint can mean. Why not brighten up?

The effect of correct materials on WELDING OPERATIONS

By H. E. ROCKEFELLER
Development Engineer
The Linde Air Products Company
New York, N. Y.



Testing the welding rod.

* * * *

PROBABLY one of the greatest benefits derived from standardization in industry has been the proper selection and control of materials. In many fields it has not been uncommon to trace the source of trouble to faulty material or improper tools used in the fabrication of material. Possibly because of the comparatively few years that acetylene welding has been extensively used, however, this factor has seldom received its due recognition. An outstanding exception to this general statement may be cited in the acetylene welding of tubing. Experiments with various steel compositions in this instance evolved a material which was entirely satisfactory for welding and which, furthermore, met all other requirements. The result has been that acetylene welded tubing has become a standard application and one surrounding which there is no longer any concern.

In pressure vessel welding there is perhaps a natural tendency to disregard the importance of the proper selection of material insofar as the shell plates and heads are concerned, since it is assumed that material which is satisfactory for the processes of fabrication, must also be suitable for acetylene welding. Both our laboratory experiments and field experience in pressure vessel welding, however, indicate that this is not the case.

Because of the nature of acetylene welding, non-metallic inclusions or impurities in the form of segregations or laminations, may cause considerable trouble. If the defects appear along the seams and are of small magnitude, they will be melted out by the heat from the blowpipe flame. If, on the other hand, they are of a serious nature, the welding heat will open them and in some cases, cause small cracks.

Although knowledge of this characteristic requires rigid specifications on the part of the buyers, it provides an excellent safeguard against the use of defective material since these defects are very visibly indicated during the welding operation. For this reason, furthermore, when the steel maker is informed that he is to supply steel plate for acetylene welding, he will be more careful in his selection of the material which is to be shipped.

The carbon content of the material to be welded should also be borne in mind. Except in special cases when the process and materials are suitably controlled, difficulties are likely to be encountered in acetylene welding if the carbon content of the steel much exceeds 0.20 per cent. The ductility of the steel, its yield point and ultimate strength, are also factors which must be considered from the viewpoint of welding. Ductility is an important factor in pressure vessel welding because of the strains to which certain portions of the base metal are exposed during the welding operation. The yield point, furthermore, must be sufficiently high that it is not exceeded in the relatively high test pressures to which pressure vessels, constructed in accordance with our recommended practices, are subjected. The ultimate strength should be such that a weld strength in excess of the base

metal strength can be reasonably assured. This for the reason that welded pressure vessels are usually designed on the basis of a shell plate design fibre stress.

To meet these conditions, the following specifications have been used by us for some time in welded pressure vessel construction.

Steel for shell plates, heads and manhole frames, unless otherwise specified, shall fulfill the requirements for firebox quality steel as given in the A.S.M.E. Boiler Construction Code with the following exceptions:

1. The carbon content shall not exceed 0.20 per cent.
2. The material shall conform to the following requirements as to tensile properties:

   Tensile Strength, lbs. per sq.in. —48,000-60,000.

   Yield Point, Minimum lbs. per sq.in.—0.5 tensile strength, 27,000 lbs. per sq.in.

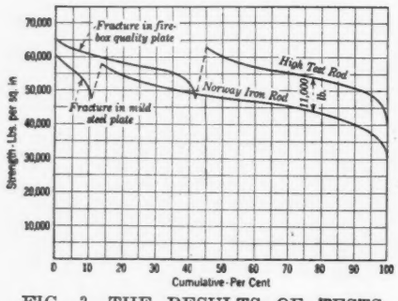


FIG. 3—THE RESULTS OF TESTS with Norway iron and with high test welding rod, plotted in order of decreasing magnitude.

* * * *

   Elongation in 8 in. Minimum, 30 per cent.
3. The tensile strength of the test specimen taken longitudinally from the top of the plate, shall not exceed 65,000 lbs. per sq.in.

   All material shall be ordered by thickness and not by weight.

Perhaps the day has passed when anyone would permit the use of bail wire for welding rod; yet this practice certainly was not unheard of a few years ago. Occasionally even today, however, ordinary steel wire purchased as such from the steel maker, is used as welding rod. Wherever any important welding application is involved, such a practice can be laid to either false economy or ignorance.

The cost of the welding rod under any circumstances when compared to the cost of the finished product, is obviously so small that even the slightest risk of poor results chargeable to this source is not justified.

FIG. 2—AN OXY-ACETYLENE welded pressure vessel (125 lbs. per sq. in. operating pressure) in service over four years.

* * * *

That there is a certain risk in using unproven welding rod, furthermore, is attested to by the extensive research which has been carried on by those companies producing welding rod and the severe inspection which they require of the rod to insure its uniformity.

Let us consider for a moment some of the factors which determine the suitability of welding rod for a given purpose. Perhaps the most important is the strength of the weld metal or, in other words, the strength of the welding rod after it has been melted and fused with the base metal. In pressure vessel welding, as in many other applications, the welded joints are so designed that with properly deposited weld metal the strength of the weld exceeds the strength of the plate.

There are many other factors, however, besides weld strength, which enter the problem. Some of these are:

1. Ductility of the deposited metal.
2. Ease of manipulation of the welding puddle.
3. Freedom of molten metal from tendency to burn or form laps, cold shuts, etc.
4. Speed of deposition.

Many thousands of dollars have been spent in research work on the development of welding rods which best fulfill for a given application, the factors above mentioned. The chemical and physical properties of the desired material do not give the complete answer. Weldability and flame tests must be run and when a satisfactory class of steel is obtained, continuous inspection must be enforced to insure its uniformity.

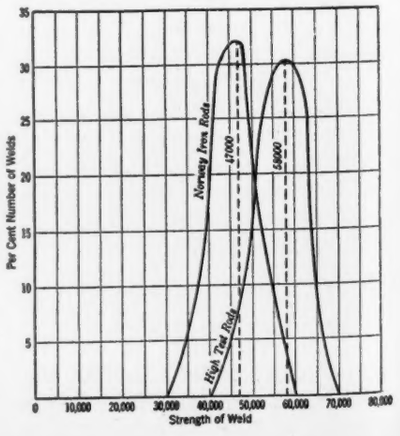
Only welding rods which have been produced and inspected by the methods outlined above, therefore, should be used. For pressure vessel construction, we have standardized upon a special "High Test" welding rod which, when properly deposited, gives a strength considerably in excess of the plate strength above specified. The added factor of safety thus gained, we feel is good insurance.

Some interesting data on the use of this "High Test" rod as compared to the ordinary low carbon rod (commercially known as "Norway Iron") very generally used for many applications is indicated in Figures 3 and 4. The data plotted includes a summary of over five hundred tensile tests of specimens submitted by welders from more than seventy-five railroad shops throughout the country and covering a period of six years. During the first three years, the low carbon rod was used and in the latter period, a rod known as "High Test Rod" was the standard.

The results in Fig. 3 are plotted in order of decreasing magnitude. The

* * * *

FIG. 4—A "PROBABILITY CURVE" plotting of the test results. The peak of such a curve gives the weld strength which may be expected.



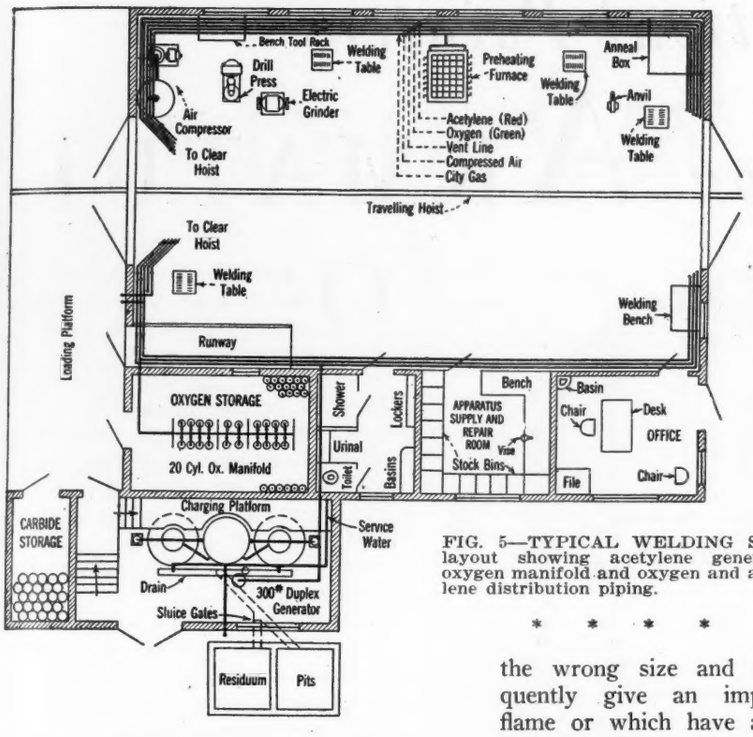


FIG. 5—TYPICAL WELDING SHOP layout showing acetylene generator, oxygen manifold and oxygen and acetylene distribution piping.

* * * *

section of each curve to the left of the broken portion indicates those specimens which broke in the plate. It can be seen that the average increase in the ultimate strength of the weld after adopting the use of the "High Test Rod" was 11,000 lbs. per sq.in.

In Fig. 4, the results are plotted in the form of a "probability curve." The peak of such a curve represents the weld strength which can generally be expected. For "Norway Iron" welding rod, as indicated on the curve, this strength is 47,000 lbs. per sq.in., and for "High Test" welding rod, 58,000 lbs. per sq.in. These results, it should be mentioned, apply to single V oxy-acetylene welds in $\frac{1}{2}$ inch plate with weld reinforcement removed.

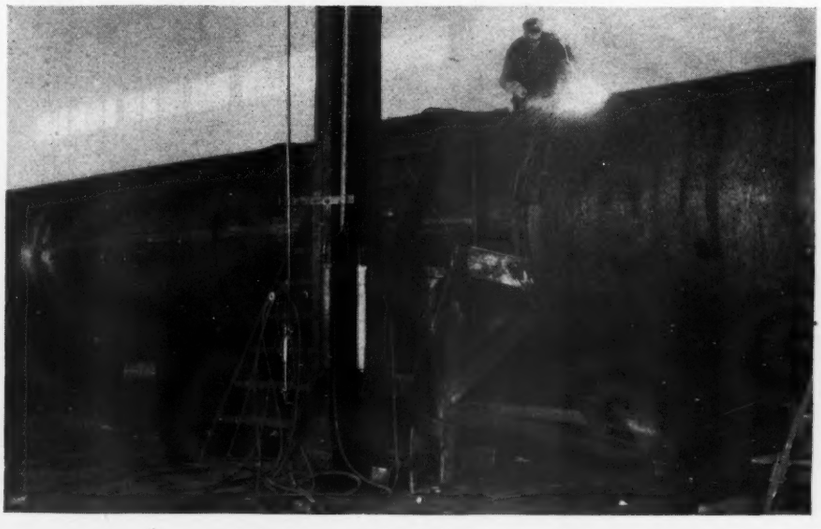
It has often been said that a good workman never blames his tools, but it is questionable, perhaps, how long a workman will remain "good" when forced to use poor equipment. This is particularly true in acetylene welding if any or all of the following conditions exist in the equipment in use:

1. Regulators which either through design or misuse will not pass the required quantity of gas at a constant desired pressure.
2. Blowpipes either of unsuitable length to protect the welder properly from the heat, or of a design which will not withstand constant service for the application in question.
3. Blowpipe tips which either are the wrong size and consequently give an improper flame or which have a tendency to clog and back-fire.

In welding, the cost of the gases (oxygen and acetylene) and their distribution amounts to a considerable item. For this reason, any economies which may be effected in this connection are worthy of investigation. Acetylene, which is generated on the premises in equipment designed for this purpose and distributed to the welding shop through pipe lines, is more economical usually than dissolved acetylene used from cylinders, where the volume used justifies the original outlay, for the acetylene generator and piping system. When dissolved acetylene is used in any considerable volume from a single blowpipe, (over 50 cu.ft. per hour) the cylinders should be coupled in multiple to gain the greatest economy in the removal of the gas from the cylinders.

* * * *

FIG. 6—OXYGEN AND ACETYLENE station, showing hydraulic back pressure valve for acetylene pipe line and station valves for oxygen pipe line.



The main advantages derived from piping oxygen and acetylene to the welding stations rather than using the gases from individual cylinders at these points are:

1. Provision for a constant supply of gases, thus eliminating shut downs during the changing of cylinders.
2. Reduction in the cost of cylinder handling.
3. Reduction in cost of welding apparatus upkeep. by the elimination of certain regulators and the more protected position of those in use.
4. Uniform regulation of pressures.

The advisability of the use of acetylene generators, oxygen manifolds and piping systems must naturally be decided for each individual shop and can best be ascertained by consulting either reputable apparatus manufacturers or oxygen and acetylene suppliers.

FIG. 7—APPARATUS for coupling acetylene cylinders in multiple.

* * * *

Practical Pointers on ARMATURE

A portable oven with three-heat, manual control is used for baking armatures in this repair shop.

* * *

Combination truck and hand loading oven, with automatic temperature control, time clock and pilot light. The method shown here of dipping and handling heavy armatures has much to recommend it.

OVENS for coil and armature baking have been built from concrete poured in forms, of brick, of wood construction with magnesia cement and magnesia blocks fastened in the interior for insulation, of ordinary sheet-iron construction without insulation, and in numerous other ways. Due to the fact that the cost of operating an oven depends upon the insulation used, the construction is of prime importance.

When considering the various types of oven wall construction already mentioned, some facts concerning the heat-absorption and radiation losses will be of interest. It is a fact that proper insulation, coupled with correct design of an oven, eliminating "through" metal, that is, metal which is placed so as to form a metallic conductor of heat, pays big dividends.

Actual tests of heat losses through various wall thicknesses and types of construction show the following B.t.u. losses per square foot per hour, based on an operating temperature of approximately 230 deg. F.

Sheet-iron, non-insulated.....	680
One-course, 4-in. brick wall.....	340
Two-course, 9-in. brick wall.....	80
Steel panel, 2½-in. insulated wall..	28
Steel panel, 4-in. insulated wall..	19

Besides the radiation losses there are several other losses to be taken into consideration. Losses caused by absorption are of considerable importance, as careful tests have shown that ovens constructed of brick, concrete, or some similar material, not only show the highest loss of heat by conduction, but also the highest loss due to absorption. In the calculation of heating systems it is necessary to supply approximately double the amount of heat for ovens so constructed, as compared with those built of properly insulated walls.

The highest efficiencies are obtained in an oven constructed of properly-insulated, steel panel walls, as practically no absorption of heat takes place; the heat is retained inside of the oven proper, where it can do useful work. This detail is emphasized because of the direct bearing it has upon the operating cost of the

BAKING OVENS

By A. H. KOPPRASCH
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Electric Service Supplies Company,
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oven. We can, therefore, draw the conclusion that a brick or poorly-constructed oven costs about twice as much to heat as one properly constructed with insulated panels. However, many steel panels have a defect, in that "through" metal extends from the interior of the oven to the exterior, and will cause a considerable amount of heat loss per day.

Another important consideration is the necessity of using structural steel for reinforcing the oven so that it can withstand the loads imposed on it, and also to prevent warping or buckling due to the heat in the interior. With steel panel construction it is possible, through the use of spot welding equipment and forming dies, to provide steel panels with insulation so that the oven will maintain its shape and give long service under continuous operating conditions, without increasing heat losses.

* * * *

THIS OVEN is electrically heated and is equipped with completely automatic temperature control, up to 500 deg. F. It is arranged for truck loading.

Doors should be heavily constructed with steel hinges and latching mechanism to eliminate maintenance on this part of the equipment. Such doors should also be well insulated so as to eliminate a cold area in the front of the interior part of the oven, and should fit tightly, to reduce the heat losses to a minimum.

Methods of Heating Baking Ovens

Many methods, including the use of oil, steam, and gas, both direct and indirect, have been recommended for the heating of coil and armature baking ovens.

The use of oil under ordinary practice is not to be recommended, as it is very difficult to maintain a uniform temperature. Steam heating systems are also difficult to control, and have the added disadvantage of being sluggish in heating up, thereby increasing the baking time to nearly double that of modern heating systems.

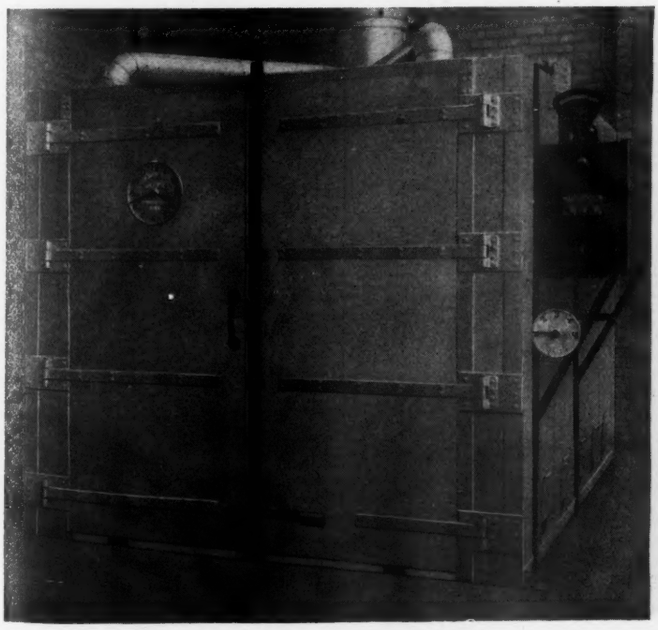
A direct gas-fired heating system is used in many shops. However, this system is not to be recommended, as the flame is very likely to come into contact with the fumes of the volatile vapors. With the proper admixture of air these fumes will cause an explosion. Such explosions have been disastrous in the past. In addition to the possibility of explosion, the difficulty of securing proper and uniform temperature control through the interior of the oven makes this method of heating undesirable.

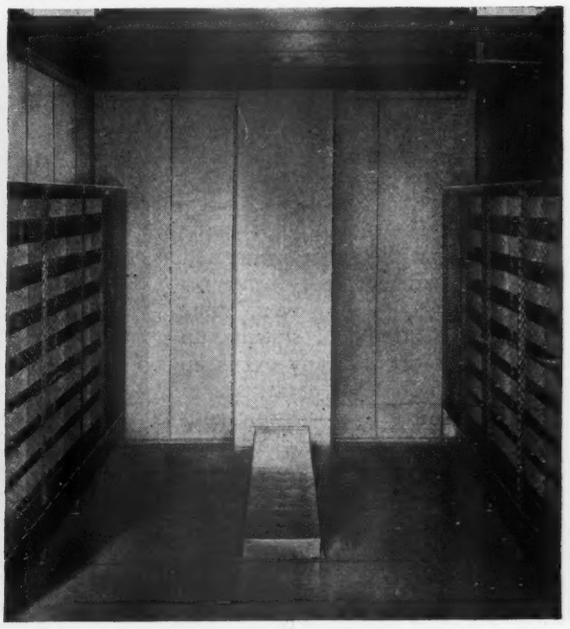
Gas heating, when accomplished by the so-called indirect-gas-fired system overcomes the above objections as to temperature control and fire hazard. This method eliminates the localized, high-temperature zones in an oven and is highly regarded for use with ovens for baking varnishes, etc., that give off a highly volatile vapor.

Electric heating is considered to be the most adaptable for coil and armature baking ovens as the resistors or heaters can be operated at a very low temperature, resulting in uniform heat distribution throughout the in-

* * * *

IN THIS OVEN the heating elements are mounted on the side walls and protected by heavy wire guards. Note the duct in the floor, for bottom ventilation.





terior of the oven, and long life of the heating elements. By operating the heating elements at a temperature below 200 deg. F., the explosion hazard is eliminated and the life of the elements is practically indefinite.

One of the many advantages of electric heating is that through the use of automatic temperature control the oven may be kept, night and day, within a few degrees plus or minus of the desired temperature, without the aid of an operator. Owing to the rapidity with which electric oven equipment reaches its operating temperature, armatures can be baked in approximately one-third the time usually required by other systems.

Another advantage of electric heating is the fact that, as no air is required for combustion, less heat is lost through ventilation. This accounts for the fact that the operating cost of an electric oven is very close to that of a gas oven, in average localities, and results in rapid and economical baking. Where natural gas is available or low gas rates apply, the operating differential would undoubtedly be in favor of the gas-fired oven.

Function of the Ventilating System

After good construction and a suitable heating medium, the ventilating system is the next important factor in oven construction. It should be designed not only to carry off the fumes that are generated during the baking process, but also to take care of other conditions which the ordinary individual does not take into consideration when contemplating building an oven.

All insulating varnishes of the baking variety dry by oxidation, and this action can take place only when considerable quantities of preheated fresh air come in contact with the surfaces to be dried. It is necessary, therefore, to design the fresh air ducts so that they may be controlled to meet operating conditions.

First, the ducts should be of ample capacity, so that the vapors generated during the baking process do not recirculate through the oven, thus hindering oxidation and slowing up the baking process. Many ovens do not properly bake coils or armatures for this reason. The scientific construction of an oven demands that top ventilation be used to carry off moisture and the lighter solvent vapors, whereas the bottom ventilating ducts should be arranged to carry off the heavier volatile mixtures, which usually settle to the floor of the oven. The correct design of ducts also assists materially in maintaining a uniform temperature throughout the oven.

The object of controlling the ducts is to provide ventilation in accordance with the quantity of work to be done. As an example, when baking only one armature the ventilation could be cut down to, say, approximately ten changes of air per hour, whereas when twenty armatures are placed in the oven, the ventilator adjustment should be set so that from 25 to 30 air changes per hour pass through the oven. It is obvious that ability to secure proper adjustment helps to obtain high production at low cost.

Good Work Depends on Close Temperature Control

Proper control of temperatures in an oven is very important. In order to drive off moisture it is customary to operate an oven at approximately 220 deg. F.; however, most authorities agree that cotton will begin to char at about 240 deg. F., so that the operating temperatures must be closely watched.

In electrically-heated ovens the temperature can be automatically held within three degrees plus or minus, and with proper equipment gas-heated ovens can be controlled within substantially the same limits. Oil and steam-heated ovens are, as a rule, more difficult to control satisfactorily.

A vapor tension instrument, which is usually an indicating and controlling device with the scale so arranged that the temperature may be adjusted for control at the heat desired, provides a satisfactory automatic control for coil and armature baking ovens. In this instrument high and low contact points operate the control circuit, which in turn includes a small relay drawing less than five watts, resulting in long contact life.

This small relay operates the main magnetic contactor, which cuts off or turns on the current for the oven. The use of relays, with the resultant cutting down of the current at the thermostat, is the approved standard method of controlling oven temperatures, and when used with a well-designed instrument that indicates at all times the temperature at which the oven is operating should give unfailing service. It is uniformity of temperature control that brings about practical baking schedules and satisfactory production in the coil and armature shop.

Proper baking, then, depends on correct oven construction, an efficient heating system, a properly-designed ventilating system, and accurate temperature control, so that parts of different cross-sectional area can be dried and baked properly in a shorter length of time, and at lower cost, than in an inferior oven.

In these days of competition, when every shop, both commercial and industrial, is endeavoring to reduce labor and overhead costs, by the installation of labor-saving devices, it is highly important to give serious consideration to the selection of the oven which is one of the most important pieces of equipment in the shop.

* * * *

COILS AND ARMATURES can be baked in ovens like this, but the excessive heat losses increase considerably the cost of doing the work.

A cable conveyor feeding logs to a movable self-propelled log stacker on standard gage track.

Odd Shapes and Sizes are no obstacle to MECHANICAL HANDLING

By E. J. TOURNIER

Estimate Engineer
Robins Conveying Belt Company
New York, N. Y.

COMPETITION in industry is keen and the factories therefore face the necessity of producing as economically as possible, which in the long run is to the good. All industries have been confronted by the problem of lower prices and increasing costs, and under the compulsion of these factors they have carried on to economical solutions of their difficulties.

In common with the jobbing foundry, the wood-working shop, for example, is facing the competition of pressed steel shapes in furniture and office equipment, steel shelving and the like. And, just as the foundry is finding its salvation in continuous process work through mechanical handling, so the wood-working industry is beginning to apply successfully the same methods to its needs.

The business of bringing out the lumber which is the raw material of fine furniture as well as of ready-cut bungalows is no longer the exclusive possession of the muscular lumber jack. The portable saw-mill and the caterpillar tractor in conjunction with conveyor chains have placed lumbering under the control of mechanical horsepower. It is now rapidly becoming a continuous process.

The establishment of barking and log-cutting equipment in the woods considerably simplifies the preliminary handling and also the cleaning of the logs. The practice of floating the wood to the mills is still in force on account of the obvious advantage of this form of conveying. In addition, floating the logs, during which a great deal of tumbling and rubbing together takes place, insures the delivery of clear raw material at the mill.

The handling of logs and wood chips has caused the adoption of two distinct classes of machinery, each especially suited to the work to be done. Rough logs do not represent a difficult conveying problem, but require equipment that is rugged and of simple construction. It is generally slow-speed machinery that will withstand heavy blows from logs dropped upon it, or that become partly wedged. The chips, however, require only a light conveyor, both on account of the method of loading and the amount carried. The loading of logs on conveyors is more or less indiscriminate and irregular, as it is performed by unskilled labor, result-

ing sometimes in some sections of a conveyor being overloaded while other sections are insufficiently filled.

Chip handling machinery is usually fed from some processing machines, such as a chipper, or a screen, and the feed is fairly regular and continuous. These various conditions, therefore, have determined the use of heavy chain conveyors for handling logs and belt conveyors or bucket elevators for carrying wood chips. This selection meets the requirements of service so well that these types of machines are practically standard in pulp mills.

Wherever continuous processes are necessary, a prerequisite of successful operation is an adequate supply of raw materials. In most industries, this supply is easily accessible by rail or water at all periods of the year, so that a minimum storage, sufficient for current use only, is required. It is quite otherwise in the lumber industry because the wood is cut in the fall and must be delivered to the mills within a short period of time. During the time between fall and early spring, the year's requirements must be taken out. The log storage is therefore the only source of supply for the remainder of the year.

Building up the log storage is expensive work which is partly manual and partly mechanical. The stock pile consists of a palisade around the periphery of the storage area, and a log pile within the bulwark formed by the palisade. The latter is formed manually by laying logs flat on the ground, with one end facing toward the center of the area. These logs are piled in layers from five to eight feet high and prevent the spread of the wood piled above them.

FEEDER CONVEYORS in the center foreground and at left deliver material to the storage conveyor shown over the pile of logs.

* * * *

The logs for making the stock pile are brought to the plant by water, from which they are guided by hand to an inclined conveyor having its loading point at the river bank. The terminal sprocket, with a short section of chain is submerged so that logs can be floated to a position where they can be taken up by hooks on the chain. This in-haul chain carries the wood to a second conveyor located 30 or 40 feet above ground and over the center of the storage area. The storage conveyor is usually made up of several strands of chain running parallel in a wooden trough. The logs are discharged through openings in the bottom of the trough.

In addition to storing logs by means of a conveyor over the storage area, they may be piled by a movable stacker. The latter consists of a wheeled truck, an inclined cantilever

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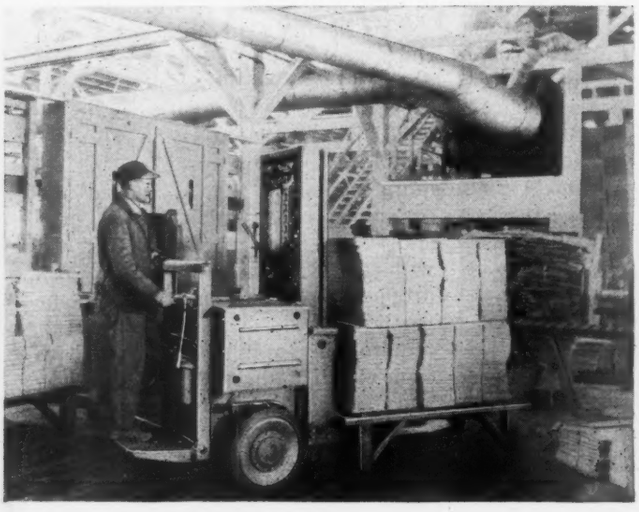
WHEREVER FLEXIBILITY is required in the transfer of material to shipping platforms or cars, this form of conveying is economical.



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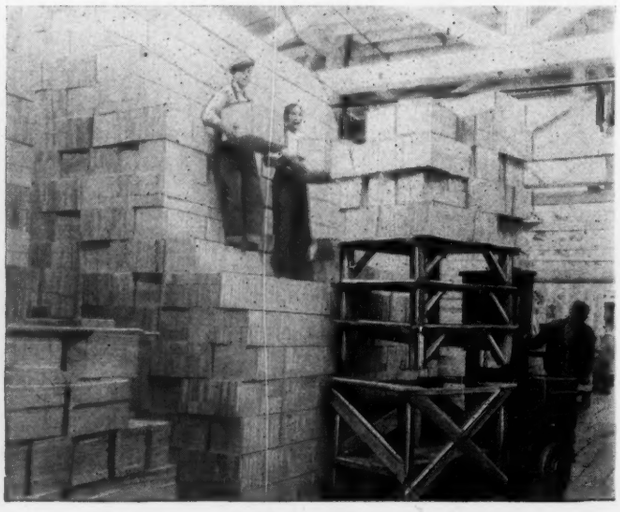
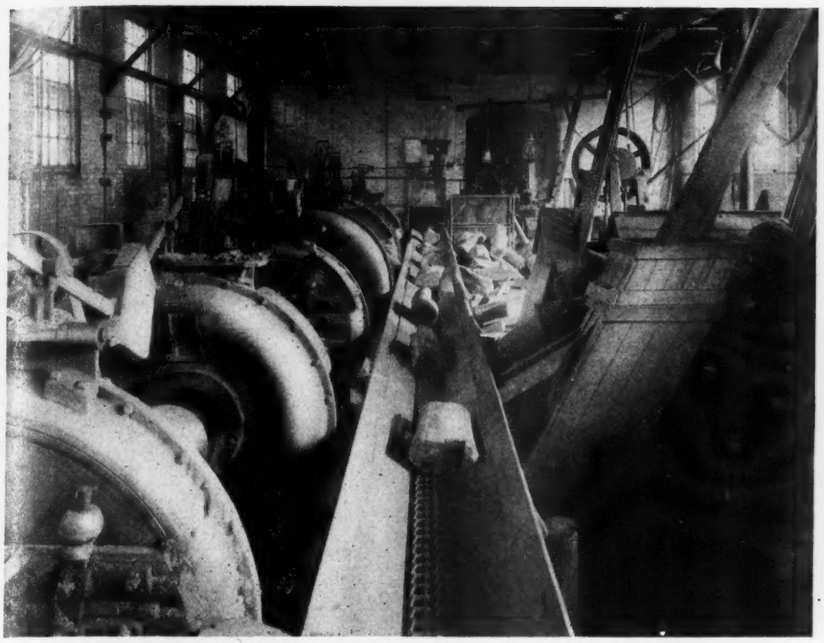
ELEVATING PLATFORM trucks speed up the handling of manufactured material in crowded workshops as well as in storage warehouses.





A DOUBLE-STRAND malleable-iron chain conveyor running in a wooden trough forms an efficient unit for serving wood chippers.

* * * *

frame carrying a chain conveyor, propelling machinery and the conveyor drive equipment. The stacker conveyor is similar to the overhead chain type previously described and may be made up of one or more strands, depending on the lengths of the logs and the capacity required. Storage piles are limited to heights of about 50 to 60 feet, if stackers are used in their formation, and about 100 ft. with fixed overhead conveyors. Reclaiming logs from the pile is accomplished by means of a chain conveyor in a tunnel under the pile. The usual capacity of log conveyors is from 15 to 20 cords per hour, or about 45 to 50 tons per hour.

The types of chains used in handling rough lumber are generally suitable for conveying finished wood work and for wood in process of manufacture. Woodworking mills are beginning to install systems of materials handling which have been successful as agencies of cost reduction in other industries. The principle of continuous handling on which these systems is based, is also the factor upon which economies depend, whether the work is to be done in a foundry or in a window frame mill.

In general, manufacturers of window and door frames have not utilized mechanical handling because the flow of material through the plant is in too complicated a path. This is due to the fact that factory extensions are made without giving thought to materials handling, in old plants. In the construction of new factories, the old ones are likely to be used as models with the result that, even in these cases, the application of conveyors is almost impossible. If a materials handling specialist were consulted, there is no doubt that suggestions could be made as to plant layout which would reduce the cost of handling the product.

In cases where the factory can standardize on sizes and types of its product, and where production is on a large scale, conveyors materially affect the cost of production.

A manufacturer in Bayport, Minn., builds exclusively outside door and window frames in all standard sizes and details. The mill has a capacity of over 4,000 frames per 9-hour day.

Raw material is received in box cars, is unloaded and inspected, then delivered to rip saws for cutting into standard sizes. This sized material is delivered directly to the cut-off saws on specially built saw-horses, which carry a large supply of ripped lumber. There are twelve cut-off saws stationed in line and about 10 ft. apart. The cut-off saws are operated by men who are expert in the grading of lumber and who are thoroughly versed in the standards of the manufacturer.

(Please Turn to Page 367)

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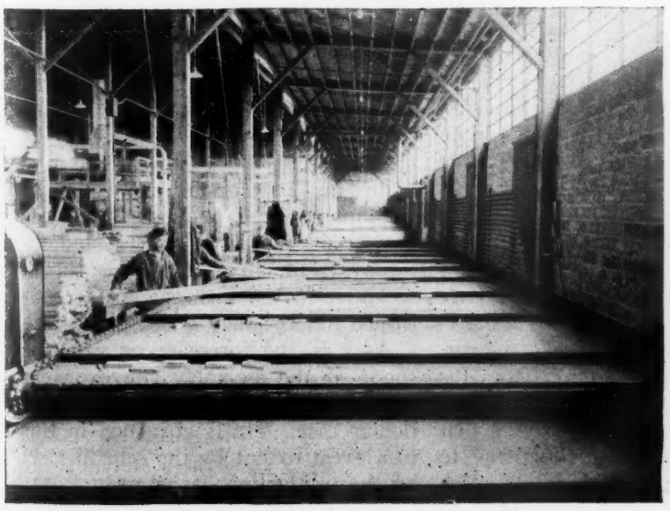
SORTING LUMBER for use in making standard window frames and doors is simplified with this type of scraper conveyor. Its use eliminates waste of wood scrap.



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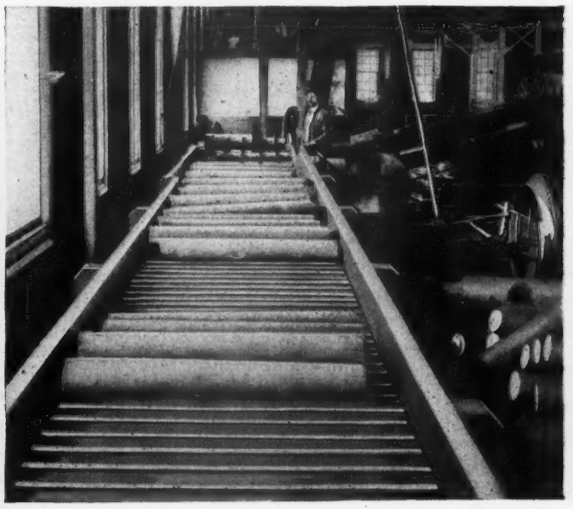
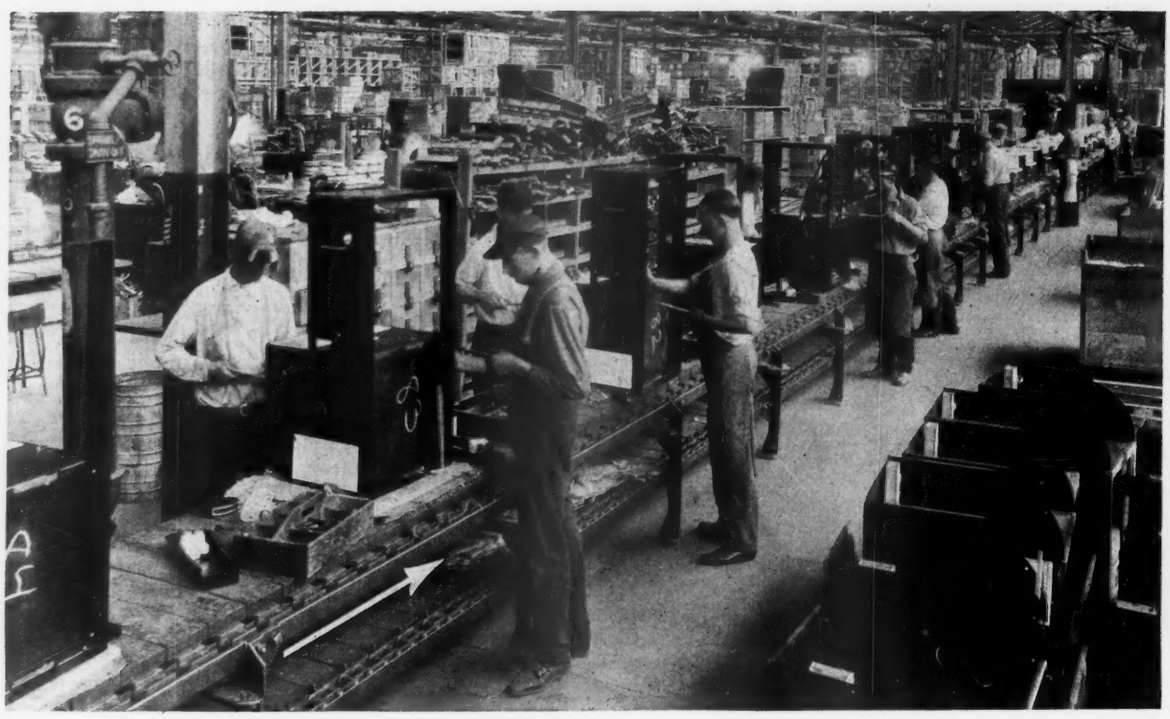
WOOD APRON conveyors are used in handling logs in the mill. This type may consist of iron, or steel roller chains with wood slats forming a continuous apron.





Assembly line for electric ranges. At full load, the conveyor travels 3¾ ft. per min.

Saving floor space and trucking with

Assembly Conveyors

By D. B. KIFT
General Superintendent
Edison Electric Appliance Company
Chicago, Ill.

HOW EASY it is to visit some plant that has a successful application of the conveyor as a moving bench upon which to carry on assembly operations, to be carried away by enthusiasm for the plan, and then rush headlong back home with a desire to "go and do likewise." This is a common weakness. But there is more to it than appears on the surface. Not all assembly jobs lend themselves to this treatment, and where they do there is a right and wrong way to go about it.

At the outset it is safe to make the assertion that a conveyor should not be used for progressive manufacturing operations unless the job has been thoroughly analyzed. Such an analysis will determine the possibility of balancing the work. By balancing the work is here meant its proper split-up into jobs each of such a duration that all the employees in the line are equally busy.

Obviously, it would be unwise to have an assembly line in which certain workmen were striving at their very utmost to keep up with the pace set by the conveyor and men in adjacent positions who were having an easy time of it. So, I say that it is very important that the job be properly balanced.

Another thing that must be absolutely insured is an adequate supply of parts. Materials must always be on hand when needed, or the whole line is upset. We feel the importance of this to such an extent that it is taken into account in our production department bonus plan. We penalize the production man if there is a shortage of parts at the assembly conveyor. The penalty is a deduction from his production department bonus.

Of course there is no denying that there is a pace-setting advantage to the use of a progressive assembly line mounted on a conveyor, but this is not such a large element with us for the reason that we have a rather comprehensive incentive remuneration plan which we feel offers a positive incentive rather than a somewhat negative one as is supplied by the pressure of a pace-setting conveyor.

Why, you might ask, not use the legs with which the men are already equipped and move the gang from one piece of product to the next down the line, instead of moving the product to the men. This would save quite an investment in conveyor equipment, true enough, but one answer is that the pace would be jumpy. Human pace-setters are not so uniform as a mechanically controlled device: they go by spurts.

As it is, the foreman can vary the speed of the assembly conveyor entirely to suit the needs of each particular case. He is governed in this to a great extent by the schedule set by the production department.

The chief reason we do much of our assembling on a conveyor is because of the space which it saves. In the case of electric ranges, for example, as close as we can figure, the space taken up is about one-fourth of what would be required without the conveyor. And besides, it would take a lot of extra flunkies to move the stuff. Not only is labor expensive, but so is floor space; more so than we sometimes realize.

We are firm believers in progressive assembly on conveyors, but I do not wish to leave the impression that putting in a conveyor is the end of all difficulties. In fact, it might as well be said at this point that an assembly conveyor requires a higher caliber of supervision than does the ordinary floor assembly job. If you don't get the thing in the proper balance there is sure to be a jam at the end of the line. This is not intended as discouragement; on the contrary, failure to appreciate these points has often resulted in disappointment.

Referring again to our assembly line for electric ranges, the general arrangement is clearly shown in the accompanying illustrations. The conveyor itself is of the slat type, the upper surface of which is 24 inches above the floor level. Under full operating conditions the speed of this conveyor is about 3½ feet per minute. Use is made of the first few feet of the conveyor for the men who place the parts ready for the starting of the assembly. Other parts are added at the proper points along the line as the assembly progresses.

Each assembler does his operation or operations on the range as it passes him. How many operations each man does depends to a considerable extent upon the production schedule. That is why it is desirable to have the various operators know one another's job. When the conveyor is running full, as in the case of an extended run under a full production schedule, this ability to do one another's job is not so necessary, for then each one does fewer operations. But in any case, the situation is rendered much more flexible if the men are all-round assemblers.

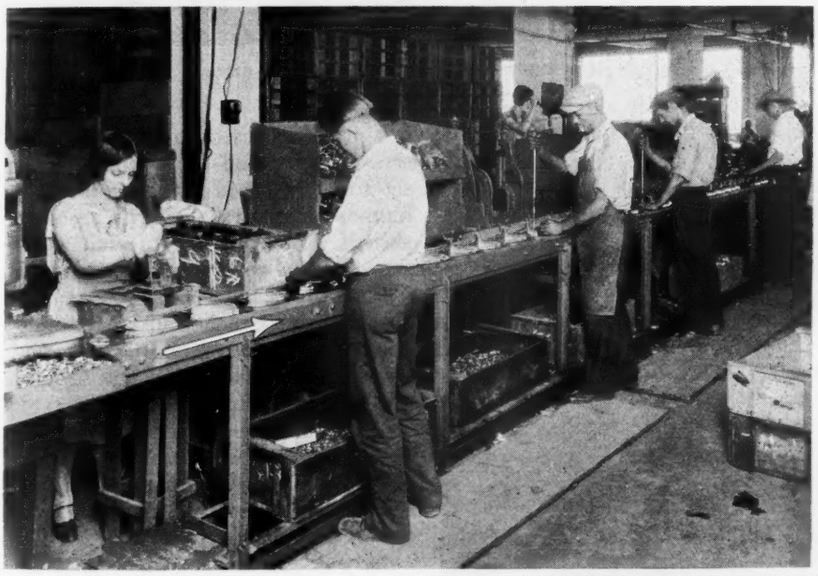
Not only is assembling done on this conveyor but also electrical testing and inspection. In fact, except with the type of range which requires a test heat run, they are even completely crated for shipment while still on the assembly conveyor. So when they come off the line they are placed immediately in stock.

But in the case of ranges which have to be given a heat run, even though it is not feasible to give this test on the conveyor, we have not forgotten to cut down handling to a minimum. Here the range is transferred from the conveyor line to a caster-mounted truck of a height which requires but little lifting and gives the right elevation for convenient testing. Furthermore the testing is done at a point only slightly removed from the end of the conveyor and from the packing benches.

In the manufacture of Hotpoint electric flat-irons we also use progressive assembly on a conveyor, as one of the accompanying illustrations shows. Here we use a special recessed link or chain type of belt. Each link is a block bearing a recess which is shaped like the iron and so holds it securely in place as assembly progresses.

Formerly each man assembled the complete iron. He would lay out the parts for a number of irons and then "go to it." This took longer than the present plan and besides there was the danger of damaging the irons in handling.

All this is avoided under the progressive assembly plan, considerable floor space is conserved and there is a notable saving in direct labor. Furthermore there is a decided reduction in trucking.



ELECTRIC flat-iron assembly on a conveyor. The conveyor is made up of linked blocks, each block being recessed to conform to the shape of the iron.

* * * *

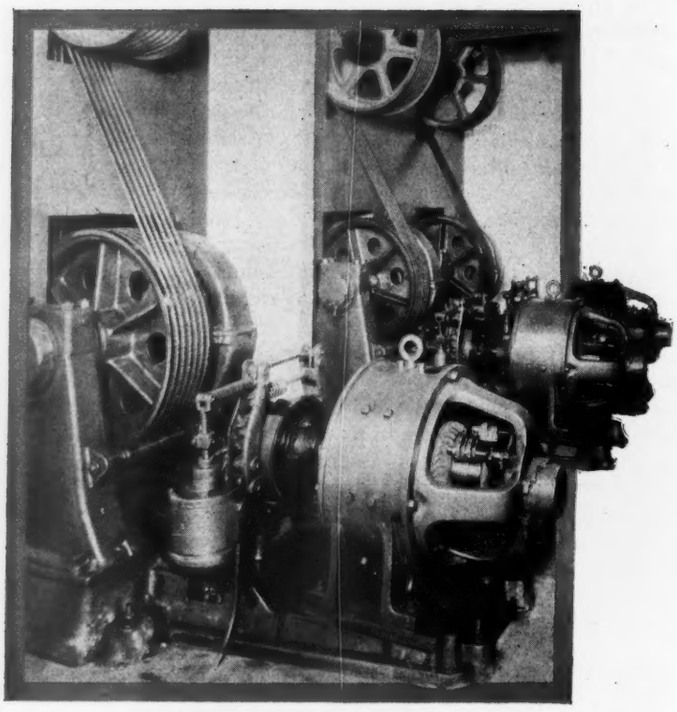
CRATING electric ranges on the end of the assembly conveyor line. This is done only in cases where a trial heat run is not required.

* * * *

J. W. COREY
Application Engineer,
The Reliance Electric & Engineering Company,
Cleveland, Ohio

describes some types of

Reversing MOTOR DRIVES



Typical reversing motor elevator drive

TO SIMPLIFY the application of power to machinery that is subject to frequent reversals, many machinery manufacturers are using reversing electric motors, consequently the object of this article is to list some of the types of drives that have come to the attention of the writer, where increases in production or lower operating costs have been achieved by installing reversing motors.

Probably, the first extensive use of electric motors for reversing service was on elevators. As buildings were extended skyward, they exceeded the limitation of the plunger-type, hydraulic elevator. Other types of drive such as steam engine and reversing-belt drives could not be controlled easily from an elevator cab. Neither could they accelerate and decelerate quickly. It was found that reversing motors were more economical from the standpoint of first cost of operation, and maintenance. These factors and the greater safety factor and smaller installation space required have made reversing motors the universal type of drive for elevators. A typical elevator installation is shown in the photograph above.

Reversing-motor drive has also been used quite extensively on slotters, replacing the crank action and counterweight, simplifying the drive and making it possible to give a choice of cutting and return speeds. Fig. 2 shows one head of a triple-head, locomotive frame slotter driven by a 20-hp., 250 to 1,000 r.p.m. reversing motor. The cut is down and the small clearance allowed for reversals at the bottom of the stroke shows the extreme accuracy of reversal.

Fig. 3 shows an application of a reversing motor to a metal-working planer. The primary reason for this application was more production. The belt-driven types of planers had two sets of tight and loose pulleys, one set for slow-speed cut, the other for high-speed return. The belts were shifted from one set of pulleys to the other to reverse the planer bed. This made a total of eight pulleys with two belts made quite narrow to allow for quick reversals. Only one speed was provided for cutting and one for the return.

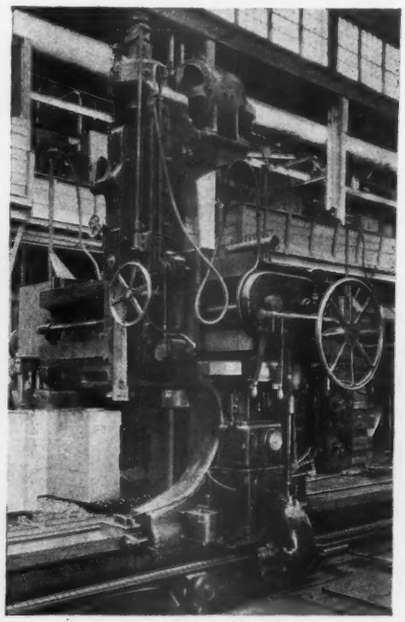


FIG. 2—ANOTHER INSTALLATION on a triple-head locomotive frame slotter. This type of drive has largely replaced the crank action and counterweight, thus simplifying the drive.

When electric motors were applied to planers they were direct connected as shown in Fig. 3, thus eliminating belts and pulleys. The drive was positive and it was found that heavier cuts could be taken. An adjustable-speed motor was used, arranged so as to give cutting speeds of 25 to 65 f.p.m. in forty steps, and return speeds of 50 to 100 f.p.m. in an equal number of steps, making it possible for the operator to choose the best combination of speeds to give maximum production. In Fig. 3, the motor is marked *M*. The automatic control is inclosed in a sheet-metal cabinet marked *A*.

Two speed-control rheostats are mounted on the inside of the cabinet door. The cutting speed and the return speed are set and controlled by the above mentioned rheostats. The stopping and reversing of the motor at the end of each stroke of the planer is controlled through the drum master switch *D*. The drum is operated by the shifter rod *E* connected to the rocker *F*, which is actuated by the

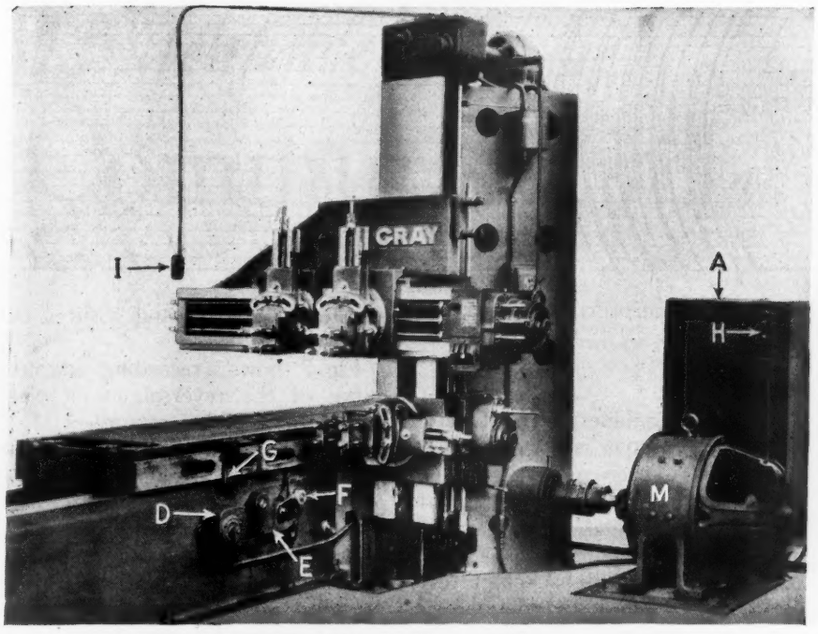


FIG. 3—REVERSING MOTOR DRIVE on a metal working plane. The adoption of the reversing motor eliminated eight pulleys and two belts. This drive is also more positive and permits heavier cuts. An adjustable speed motor enables the operator to choose the best speed combination.

dog *G*. The travel of the table in either direction is determined by the setting of the two dogs.

The two upper buttons of the station *H* are used for ordinary starting and stopping. The two lower buttons serve as a transfer station for changing the control from the drum master switch *D* to the pendent setting-up switch, *I*. The switch *I* is used only in setting up work.

Many times in designing a machine, a considerable saving can be made in the equipment by the proper application of a reversing mechanism. Fig. 4 shows a special machine for shaping the door frames for large safes. The shaper head, machines in and out. The head travels and the work remains stationary. A reversing motor was connected to the shaper ram after the designer had spent considerable time laying out a mechanical reverse. It was estimated that $1,500 was saved in the design of the machine by applying the motor drive.

During the tests in developing reversing motor drives for machinery, many interesting facts were brought to light.

A 25-hp. motor at 250 r.p.m., was reversed 75 times per minute. At 500 r.p.m., the same motor could be reversed 24 times per minute. This developed the fact that due to the greater inertia of high-speed machines it was impossible to get a great number of reversals per minute with them. It was possible to build long and smaller diameter rotors which reduced the flywheel effect, but as the amount of inertia to be overcome varied with the square of the speed and directly with the diameter and weight, much higher frequencies of reversals could be obtained by using lower-speed motors.

Where very accurate timing of the reversals to take place at a definite point in an operation was required, or where very rapid reversals and speed adjustments were necessary, a direct-current motor was used.

In general, all other applications lend themselves to alternating as well as direct-current motors.

Laundries use washing machines and most laundries are cramped for floor space. Also, rooms filled with steam and moisture usually do not tend to prolong the life of belts.

* * * *

FIG. 4—SAFE-DOOR SHAPER with reversing motor drive. It was estimated that the motor on this shaper saved $1,500 in the design alone. Here, the work remains stationary.

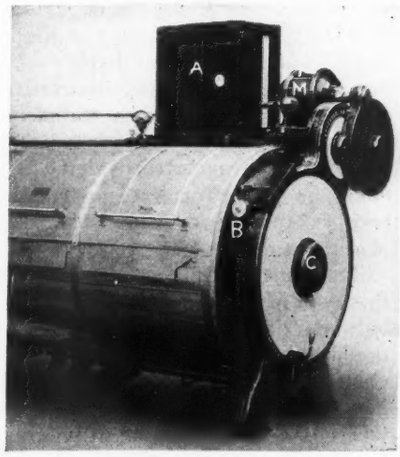


FIG. 5—REVERSING DRIVE on a washing machine. The motor drives the washer cylinder through gears. The motor *M* and controller case *A* are mounted directly on top of the washer cylinder in order to conserve space for other laundry purposes.

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FIG. 6—THE REVERSING motor drive doubled the output of this paper plater. The motor, indicated by the arrow, is automatically stopped and reversed without delay.

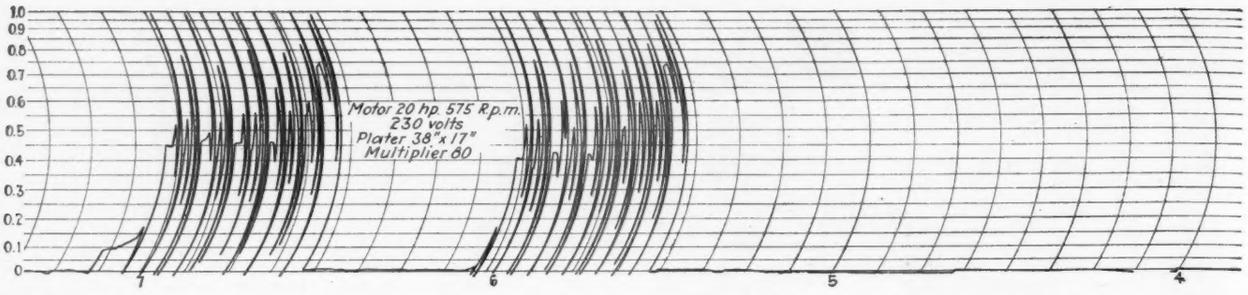


FIG. 7—RECORDING WATTMETER curve of the reversals on a plater driven by a 20-hp. motor.

It was natural therefore that reversing motors were immediately adopted for this class of work. In addition to eliminating belts and pulleys, with their attendant high maintenance and repair costs, this type of drive is capable of sustained operation hitherto considered impracticable with the old system.

Fig. 5 shows a washing machine with a semi, high-torque, squirrel-cage motor driving through gears directly to the washer cylinder. The motor *M* and controller case *A* are mounted directly on top of the washer. The equipment is started, stopped and inched by pushbutton *B*. The inching feature is present to bring the cylinder opening into line with the opening in outer case.

A timer station is connected to the cylinder shaft at *C*. This station can be adjusted for reversing the washing cylinder from six to twelve times per minute. The contacts in this station act as pilots to control the reversing contactors in cabinet *A*.

This same type of drive has been worked out for similar machines used for dyeing yarn, where the cylinder reverses after each revolution and for dry-room tumblers in dry-cleaning plants.

Certain grades of paper which require a highly finished surface, such as paper for playing cards, are finished on a machine called a plater. Each sheet of paper is placed between metal sheets prepared to give the finish desired. Stacks of alternate sheets of metal and paper are built up to six or eight inches. These stacks are then run back and forth between the rolls of the plater under very high pressure. The passes vary from five to eight depending upon the grade of paper and the finish desired.

* * * *

Platers are driven by motors varying from 10 to 30 hp. at either 450 or 600 r.p.m. The operator in Fig. 6 has his hand on a small drum switch that controls the forward and reverse passes. As each pass is completed the switch handle is immediately thrown to the opposite position. The motor is automatically stopped and reversed through the automatic panel *A* without delay.

The quickness of reversals with this type of drive as compared to the old belt drives made it possible to double the production of the machine as it was found practical to handle stacks prepared by six girls, where the former drive could only handle the output of three.

This same drive has been installed using an automatic timer station which gives a certain number of passes and then discharges the stack. This prevents an operator from slighting his work and assures uniform quality.

Fig. 7 shows a recording wattmeter curve of the reversals on a plater driven by a 20-hp. motor.

Surface grinding machines have a long table with a magnetic chuck on them for holding the work. The table is then traversed a certain distance carrying the work in under a grinding wheel. The table is then reversed and the operation repeated until the piece has been ground to its proper dimension. Fig. 8 shows the table driven by a 5-hp., 600-r.p.m. reversing motor.

The wheel drive is an adjustable-speed motor not shown in the illustration below. With the adjustable-speed drive, it is possible to get the best speed to suit the wheel and the nature of the material. The speed of the grinding wheel, however, can be kept constant as its diameter is decreased.

Fig. 9 shows the automatic drum master switch *A*, which is operated by the action of the rocker *B* and dogs *C*.

These features help to maintain a standard of quality and make for increased production and for a better finish.

Many other applications could be described but these will tend to show the possibilities of this type of drive.

* * * *

FIG. 8—GRINDING TABLE driven by a 5-hp., 600-r.p.m. reversing motor. Here, the table carries the work in under the grinding wheel.

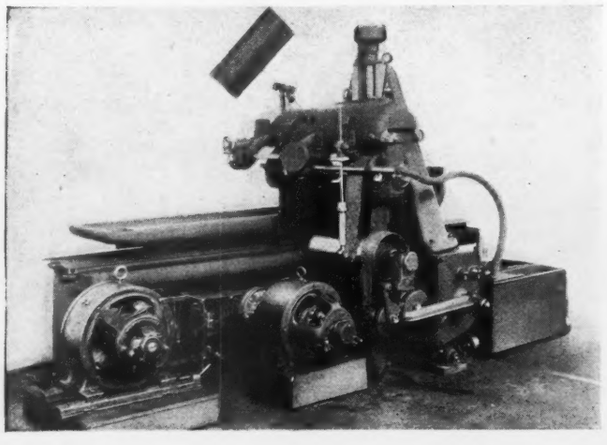
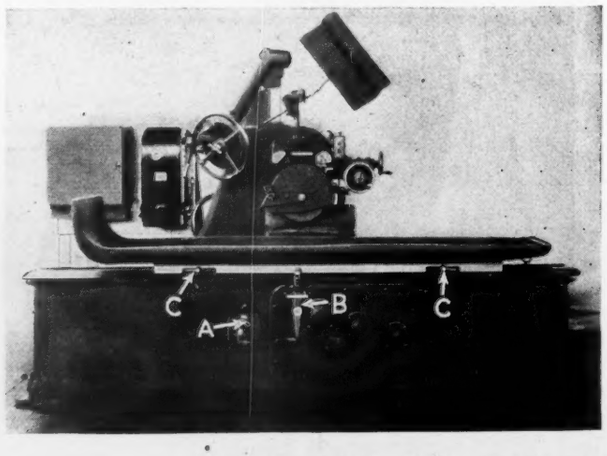


FIG. 9—THE MASTER SWITCH *A*, operated by the action of the rocker *B* and dogs *C* prevents an operator from slighting his work.



Maintenance of Commutators *and* Brushes

By V. E. JOHNSON
Electrical Engineer, Milwaukee, Wis.

COMMON causes of defective commutation and the methods of overcoming them were discussed in the second article of this series, in the May issue. In this, the concluding article of the series, the maintenance of commutators and brushes will be discussed in some detail.

In spite of its apparent simplicity, the commutator is a complex structure that must overcome in its design the inherent weaknesses of the materials out of which it is made. There have been sporadic attempts to use aluminum and iron to replace the copper, and, particularly in the early days, fiber in place of mica, but to date these have been commercial failures.

Fig. 1 shows a section of a typical modern commutator. There are many variations in the arrangement of the spider and V-rings, but the general designs are alike. The first essential to successful operation is tightness. The insulation for the V-rings and segments is all of built-up mica made of flakes cemented together with a suitable binder. This binder softens under heat, so that repeated baking and tightening is necessary in order to obtain a properly "set" commutator. It is practically impossible to season a machine completely at the factory; hence it is to be expected that the V-ring bolts will need taking up at least once after a period of service.

Judgment must be used in this operation, for it is evident from Fig. 1 that undue tightening of the studs will cause the bars to bulge away from the spider. Even a very slight bulge will disturb the mica. Some manufacturers provide so-called "click" wrenches that give an audible indication when the pull on them has reached the safe limit. This click indication is not a very accurate measure of the commutator tightness, but it does obviate the danger of distortion.

On long commutators, the increased tendency to bulge is overcome either by using shrink rings or a three-ring construction. Both of these schemes are shown in Fig. 2.

In a new machine, even with the most careful shop workmanship, the drying out of the mica may result in the loosening of one or more bars. This is often not noticeable when the machine is standing still, but in operation the loose bars are thrown out by centrifugal force, and cause a distinct knock against the brushes.

Ways of Eliminating Defects in Commutators

Extreme roughness or eccentricity of a commutator can be remedied satisfactorily only by turning or grinding. Unless a great amount of stock is to be cut away, the latter method is preferable because it can be done at normal speed.

If turning is necessary wasteful cuts should be avoided and the tool should be set below the center line so that the commutator cannot be damaged by gouging.

A hand stone will give good results if the commutator is merely rough, but it cannot be used to remedy eccentricity. A rigid rest, such as shown in Fig. 3, is always to be preferred. Rotating grinders, one of which is shown in Fig. 4, are also available, with which fast and satisfactory work can be done.

With any grinding device the best results are obtained by using wheels or stones especially made for use on commutators. Ordinary stones usually pick up copper and become useless in a very short time.

If the commutator is ground or turned in its own bearings, a stop must be used to eliminate end play, and care taken to see that none of the copper grindings or turnings get into the armature windings; fine copper dust from rotary grinders will find its way through surprisingly small cracks and crevices. The space between the commutator necks must be stuffed tightly with cheese cloth; or use may be made of a circular cardboard shield tied to them.

It is possible to turn or grind a motor armature running under its own power, but extra precautions are necessary to prevent grounds or shorts. The lathe rest must be insulated and shields used to prevent damage from flying particles of copper. Frequently, all the brushes except those in two top studs are removed. These must, at the completion of the job, be carefully freed from imbedded copper.

It is always preferable to turn or grind a commutator at its normal operating temperature. Generators are sometimes heated by running them on a short circuit with very low separate excitation on the shunt fields. On interpole machines, care must be taken that the brushes are set at neutral, or at least not back of neutral. If this precaution is not observed, a heavy current will flow when the short-circuiting switch is closed. The series field should be disconnected or reversed.

Most commutators are undercut at the factory, but after turning or grinding, the slotting must, obviously, be renewed. This can be done with various types of home-made scrapers and saws, but faster and better work can be done with a power slotter, a typical design of which is shown in Fig. 5.

The slots should be about $\frac{1}{16}$ in. deep, and the edges of the bars should be rounded. In operation afterwards care must be taken that the grooves do not become filled with conducting dust. With high-speed machines this is a remote contingency, but on slow-speed units it may be necessary to clean the slots periodically with a stiff brush or fiber scraper.

The mica between the bars sometimes rots out in spots, usually because of excess oil. These holes, unless repaired, grow rapidly larger

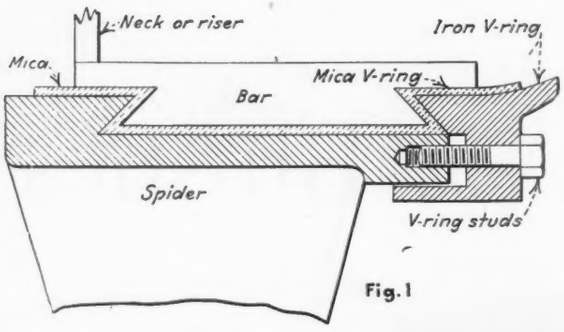


FIG. 1—SECTIONAL VIEW of a typical, two-ring commutator.

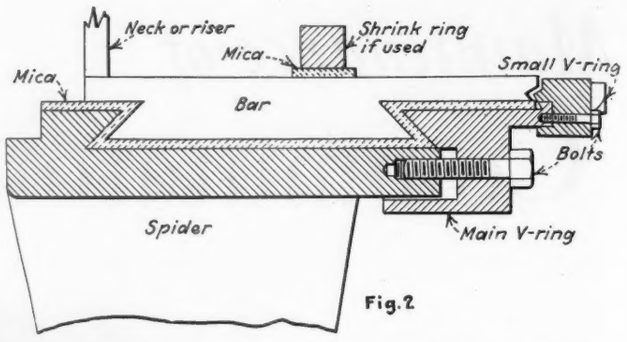


FIG. 2—THIS SHOWS the construction of a three-ring commutator.

* * * *

and may ultimately cause a serious short circuit. The disintegrated mica should be carefully dug out and the cavity filled with a good commutator cement.

Selection and Care of Brushes

Brushes are made principally from carbon, and natural and artificial graphite, combined in various proportions in order to obtain the desired electrical and mechanical characteristics. On non-undercut commutators, the required abrasive qualities are obtained by using a "mix" consisting chiefly of carbon, with some graphite added for lubricating purposes. Special high-abrasive brushes are available for use on machines in which hard mica is used between the commutator bars.

On undercut commutators, abrasive qualities are unnecessary, so that the proportion of graphite may be increased. Some grades of brushes consist almost entirely of it. For a carbon brush the current density is limited to 35 or 40 amp. per sq.in., and the peripheral speed to some 3,500 ft. per min. The addition of graphite permits a corresponding increase in current density and peripheral speed, the present limits being about 65 amp. per sq.in. and about 6,000 ft. per min.

Each type of brush produces a corresponding and distinctive commutator surface. Thus, some grades produce a chocolate-colored polish, others an irregularly mottled appearance, and still others a scratchy surface. There is really no preference as between these, in spite of the fact that tradition favors the dark chocolate finish. Pure graphite brushes often groove a new commutator, but for some reason this action largely disappears, after a stoning or two in service.

It is evident, then, that there is no short and royal road to be followed

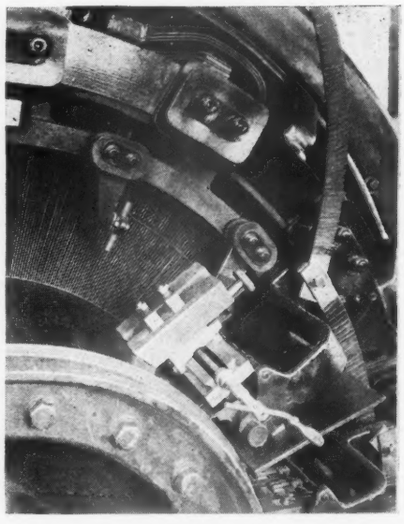


FIG. 3—REFINISHING the commutator of a 1,500-kw. rotary converter with a grinding tool. The commutator stones are held firmly in the grinding tool, which is bolted to a brush stud or the frame of the machine, and moved across the face of the commutator by the crossfeed. Courtesy The Martindale Electric Company, Cleveland, Ohio.

* * * *

in selecting brushes, as consideration must be given to all the design characteristics. The specifications are based upon a knowledge of the conditions to be met, and are drawn up in collaboration with the brush maker's engineers. Sometimes, particularly on new designs, difficulties that even the most rigid shop tests failed to reveal develop in actual service, and in that event changes may be necessary.

It is common experience, however, for an operator to spend time and money by embarking upon a series of changes based upon recommendations of more or less doubtful authority, only to find in the end that the original set of brushes give the best all-around results. As a matter of fact, the temptation to experiment is largely an after effect of old times when brush application was a matter of combined luck and patience with comparatively little trustworthy information available as a guide.

The brush shunts (or pigtails as they are sometimes called) should be of ample cross-section and securely fastened both to the brush and to the stud. The connection to the former is generally permanent, although some bolted-on types are available. The latter permits a little saving, in that renewal brushes are bought without shunts, but the poor connections which may result more than offset this advantage. The shunts should be shaped so as to permit free play or movement of the brushes in the holders.

Brushes should be fitted to the commutator very carefully, although it is doubtful whether very much is gained by "finishing the faces with fine sandpaper pulled in one direction" as was the rule not so long ago. If the coarse paper is held close to the commutator so that the curvature will be correct, a few minutes operation will effectively remove the small irregularities present in the brush face.

Lubrication of Brushes

The use of brush lubricants is practically taboo on modern machines. It is claimed that this is unnecessary because of the brush materials used and also that it may start a cutting action or have other deleterious effects. There was a time, however, when every engineer had his own favorite formula for a commutator compound and his own method of applying it and, strange to say, oftentimes achieved results that were really remarkable.

Summing up what has been said previously, satisfactory operation, which does not necessarily mean sparkless commutation, of a d.c. motor or generator is obtained only when the field form, commutator, and brushes are designed as a unit. Changes in compensation, in brush quality, or in other design characteristics should be made only after

it is certain that the fault does not lie elsewhere.

Inasmuch as sparking is one of the most frequently encountered troubles the following outline will be helpful as it shows, in the order of their probability, the commonest causes of sparking:

OPERATING CONDITIONS

1. Overload.
2. Undervoltage.
3. Wrong speed.
4. Vibration.

COMMUTATOR TROUBLES

1. Dirt on surface.
2. Dirt in slots.
3. High mica.
4. High or loose bars.
5. Eccentricity.
6. Badly grooved.
7. Rough.

BRUSH TROUBLES

1. Stuck in holders.
2. Poor fit on commutator or in holders.
3. Spring tension wrong.
4. Worn too short.
5. Chipped or burned faces.
6. Shunts not all attached.
7. Wrong position.
8. Wrong spacing.

FAULTS

1. Open-circulated coil. This causes a ring of fire all around the armature and a burned spot between the bars leading to the open coil.
2. Ground on armature, field or interpoles.
3. Interpole coils shifted on core.
4. Interpole coils partially shorted.
5. Interpole windings reversed. This will cause violent sparking and probably a flashover.

FAULTY DESIGN

1. Wong air gap.
2. Improper compensation.
3. Improper brush characteristics as to cross-section, thickness or resistance.

Guesswork is a poor tool to use in solving troubles of any kind, including defective operation of a commutator or brushes. Therefore, when such defects present themselves and call for an effective remedy, the first step is to determine the cause by a systematic checking up of the conditions outlined above. When the cause is discovered, the remedy is obvious.

FIG. 4—ABOVE a commutator is being trued up by a rotary grinder. The grinder is bolted to a brush stud or bearing cap and the abrasive wheel driven by a small motor. The commutator is driven at full speed while being ground. Courtesy Jordan Bros., Inc., New York, N. Y.

Mechanical Handling

(Continued from Page 359)

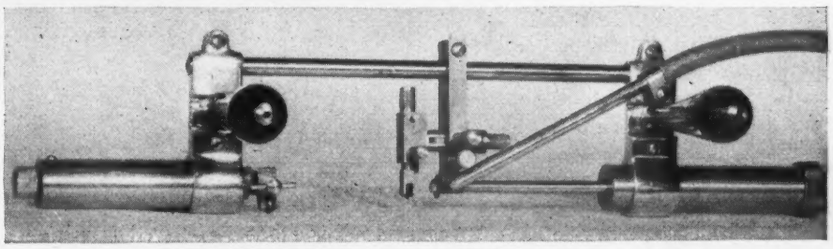
After leaving the cut-off saws in the form of standard lengths and widths, and including scrap, the material is dropped directly onto a scraper conveyor which runs along the entire line of cut-off stations. This unit is known as the sorting conveyor.

The sorting table is a conveyor made up of two strands of malleable iron roller chain, spaced about 14 ft. apart. The two chains are connected by angle irons at intervals of 6 ft. along the length of the conveyor, which is 185 ft. long. Between the upper and lower strands of chain, a table made of wooden flooring, serves as a slide for the angle iron flights, and to carry the material to be sorted. The latter is pushed along the smooth surface of the table with very little friction. The inclined scrap conveyor is of the same specifications as the sorting table except for the length and spacing of the flights. The latter are lighter weight angles, spaced 3 ft.

The conversion to new uses of well-known forms of conveying apparatus is exemplified by the application of the modified flight conveyors referred to in the present article. Double strand chain conveyors with pushers or "flights" at intervals have been used since the beginning of the modern mechanical handling art for conveying materials in troughs, and their adaptation to the present case is a logical development. It is a practical certainty that the devices developed for handling materials in one industry will serve equally well in some other. It is for the plant engineer to discover the proper kind of equipment and its application.

* * * *

FIG. 5—POWER-DRIVEN commutator slotting machine. The cutter, which is mounted on the end of the shaft at the right, is driven by a small motor through a flexible shaft. Air is blown from the tube above the cutter shaft and keeps the path of the cutter clean by removing dust and chips. Courtesy The Hullhorst Micro Tool Company, Toledo, Ohio.



The PLANT ENGINEER'S

Conducted by F. M. GIBSON, *Consulting Editor*
Plant Engineer at American Sugar Refining Company

ONE OF the products of a Pennsylvania plant requires considerable power but very little heat for production and the equipment is such that when the sales department sells a large quantity of this particular article, the steam systems are unbalanced. At such times the exhaust system is overloaded and a great deal of steam is exhausted into the atmosphere. A careful study of costs shows that 70 per cent of the extra profit secured by increased production of this article is lost in the cost of the steam "blowing off the roof."

"STEAM BLOWIN' OFF THE ROOF"

I am acquainted with the engineer responsible for the layout of the plant and know that he is very intolerant of peak loads in operation. There is no question in my mind but that he exaggerated the amount of peak load due to lack of scheduling production and neglected these abnormal conditions in factory operation that are good money makers. The ability of equipment to produce when the market is favorable is frequently far more profitable than savings in the cost of installation. A knowledge of the abnormal conditions that frequently occur in production programs is probably the most valuable asset of the industrial or plant engineer.

* * * *

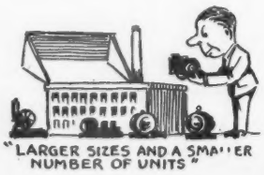
The incorrect use of averages is not only apt to hinder the flexibility of a plant but is also frequently poor engineering. Fans, motors, centrifugal pumps and other service equipment are too frequently designed for best efficiency at an average load of say 80 per cent. Examination of the loads generally reveals that most of the time the equipment is operating with a load factor of 70 per cent and 90 per cent and that the efficiency curve should be a high flat line between these points.

"BLACK SMOKE AND WHITE SMOKE"

This subject was illustrated to me in a very effective way by a master mechanic to whom I had complained that the work of the department was not at its best. He mentioned some jobs that had been well and efficiently done and was told that while there had been some good work, the average was low. The boiler house in this plant had two stacks and was burning oil. One morning I had occasion to ask the master mechanic why there was white smoke issuing from one stack and black smoke from the other, both conditions indicating poor operation. He told me that I ought to at least admit that the "average was good."

* * * *

In the designing of industrial plants, larger sizes and a smaller number of units, not only of capital but auxiliary units as well in both power and service equipment, are very attractive to the designers. The central station power plants have followed the practice to a greater extent than have the industrial plants although the latter are showing an increasing tendency in that direction. The practice has an important effect upon the amount of spare equipment provided. The industrial engineer is concerned not only with the amount of spare equipment available in case of emergency, but also with the effect of the growth of the plant upon spare equipment. Frequently a plant is just as dependent upon service equipment as it is upon boilers or power generating units and it is with this type of equipment that the engineer often has his greatest worries.



"LARGER SIZES AND A SMALLER NUMBER OF UNITS"

Consider some service equipment, such as water supply pumps for cooling or condenser service, installed in 2 units, each unit with a 100 per cent load capacity, or in other words 100 per cent spare capacity. If one pump is out of service on account of a major breakdown or a general overhauling the operation of the plant is dependent upon one unit. Anyone of a half a dozen things may put that unit out of commission and the plant be shut down with a cost of spoiled product several times greater than the cost of the pump, to say nothing of incidental losses.

This, of course, would be unusual but such abnormal conditions seem to occur without rhyme or reason and usually at the most inconvenient time. Also, the large unit may seldom be used at its most economical load, usually at a smaller load. As the plant increases in capacity there is a greater demand for water, both pumps are placed in service at a low load factor and there is no spare unit when the plant is operating at full capacity, a time when production is most essential to profits. This condition may continue for some time, depending upon the time required to convince the management that money should be spent for an additional unit.

Consider the same plant equipped with 3 units, each capable of handling 50 per cent of the load. During periods of small quantity production, of shut-down periods when a small quantity of water may be required, and periods of starting up or shutting down a plant, advantage can be taken of operating a small unit at better load factor. In case of the failure of two units, there is still 50 per cent load capacity left. When the load increases beyond the original 100 per cent load, the smaller units will have a better load factor than the two 100 per cent units.

To my mind, the 3 units of 50 per

Forum

cent load capacity will give lower operating costs, due to better load factor, than the 2 units of 100 per cent load capacity and, even if they were not more economical the difference in cost would be small insurance to pay against a possible complete shut down at enormous cost. If you do not agree with this, let us have the benefit of your opinion in the Forum.

* * * *

In student days it was impressed upon our minds that "engineering is an exact science." After many years of experience in industrial engineering, I am not inclined to accept that statement unless there is added at the end of it the word "sometimes." Last week while operating with a constant electrical load, an additional load equal to 10 per cent of the load already on the board was added. The resultant load was constant but only 3 per cent greater than the former

load. This cannot be explained by a simultaneous drop in other loads nor by power factor, because the records of conditions prove that such was not the case. I have seen this phenomenon occur several times, when an additional load did not increase an accumulated load to a corresponding amount. Why is it? Does this happen to me only, or does it happen to other engineers also?

* * * *

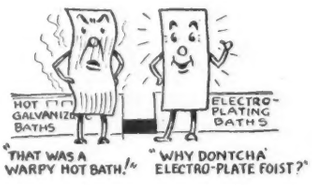
There may be a slight difference in the efficiency of a new worm gear as compared with that of a new spur gear, but what is the difference of efficiency of a worm worm gear as compared with that of a worn spur gear? One of the early makes of storage battery industrial trucks was equipped with a spur gear drive. I started an installation with 3 of these trucks; they are still in operation and operating with practically the same current consumption as when new. Later on, the manufacturers of these trucks ceased making industrial trucks and when additional trucks were purchased every make of truck on the market was equipped with worm gear drive. Cost records show the cost of upkeep on the spur gear drive to be

much less than that of the worm gear drive and, as far as comparison could be made, the efficiency of the worm gear dropped more rapidly with wear than did that of the spur gear. This may not be a fair comparison. I have seen the result of some investigations made at the Massachusetts Institute of Technology upon the loss of efficiency in worn spur gears and the loss was greater than one would expect. I hope that some day some one will investigate the efficiency of worn worm gears or, better still, make a comparison of efficiencies of the two types of drive after performing the same amount of work.

* * * *

A problem was submitted to me a short time ago by Frank Hopkins and it is a very good one for discussion in this Forum. His plant uses a large number of sheet iron plates, 12 x 30-in. of No. 8 gage. These plates are washed in water after each period of use, and corrosion occurs from the washing. It is a mild corrosion due to moisture in normal atmospheric conditions and is not caused by acid reactions from the product. The problem is to prevent corrosion of the plates at small expense. The only metal that cannot be used, due to the nature of the material with which the plates come in contact, is copper.

At present the plates are galvanized by the hot dip process, which is not expensive, but the life of the galvanizing is rather short and there is a certain warping of the plates due to the hot dip. The use of non-corroding steel alloys at 30c. and 50c. a pound is too expensive. My experience has been that the best way to get greater wearing service from galvanizing is to electroplate first with a thin coat of copper and then galvanize by the electroplating process. A layer of .002 in. put on slowly at low voltage gives very good wear but an .001 in. applied at high voltage will give a much smoother and better wearing surface although the resultant layer will be only .002 in. thick. This will cost twice as much as the hot dip but the longer life obtained will more than pay for the additional cost. It may be that some of the readers of the Forum have found a way of preventing corrosion by the use of pure irons or by some other means and will be kind enough to send this experience to the Forum.



AS THESE pages go to press, it is still rather early to expect a response to the invitation extended in my closing paragraphs in last month's Forum. In case any of you failed to note it, may I say again that these pages are here for *your* use; a place where you may discuss your problems, and where we can all meet informally each month to exchange experiences and widen our individual horizons.

The sketch which appears below is repeated from last month's Forum. Lest there be any doubt, it might be well to explain that this is our artist's conception of the way you men fell over each other to mail your letters to this department. It isn't necessary to take it literally. In fact, you may prefer to put your stuff with the office mail. But, whatever method you elect, I am counting on you to make these pages a real Forum for presentation and discussion of a wide variety of views and experiences, rather than a one-man loudspeaker. As the advertisers say—obey that impulse!

Unattended Industrial Substations

(Continued from page 332)

ment other than that required to compensate for the variations of shunt field circuit resistance when paralleling a cold unit with a hot unit. Where there are no other stations to carry through an emergency shut-down, it is customary to provide a spare, or standby machine. Figs. 2 and 3 show two views of such a station, comprising, at present, three 500-kw., 250-volt motor-generator sets.

Operating Features

It is entirely possible to incorporate in the automatic equipment whatever features are necessary or desirable to meet the local conditions. In the majority of industrial applications the first unit is started by a pushbutton located either on the switch board or at some remote point, or by time clock. In some cases it is convenient and feasible to start the remaining units in the same manner. In most cases, however, it will be found desirable to start and shut down the remaining machines automatically on load demand as needed. Machine load factor can thus be improved and conversion losses minimized. It has been proven to be most reliable, and in most cases it is very desirable to provide full automatic sequence once the initiating contact has been closed. That is, the machine will be started, synchronized and connected to the d.c. bus automatically. Where a competent attendant is available for starting the units, the closing in on the d.c. end can be arranged for manual operation. In certain cases it may be expedient, although undesirable, to arrange the whole starting sequence for manual operation. In any case the protective equipment must be full automatic if the station is to be operated unattended.

Operating Results

The selection of a size and type of conversion unit suitable for the particular application under consideration will have a considerable bearing on the economic and operating results. The capacity should, of course, be selected from the standard commercial ratings. Where the load is fairly steady over long periods, the size of machine required is determined by its ability to carry and commutate the load continuously without overheating the windings or commutator. Where the load is of a highly fluctuating nature the size of machine is determined by its ability to commutate the peaks and load swings, and not by heating. For example, an ore dock load is characterized by very rapid and steadily recurring load swings of short duration but repeated at intervals as low as one minute or less over periods of six or eight hours. The magnitude of these peaks will usually reach two to three times the R.M.S. current. Commutation is, in this case, obviously the limit in machine performance, and the machine size should be selected on that basis. In this connection, it must be realized that the commercial momentary overload rating, 75 per cent for continuous-rated machines and 100 per cent for nominal-rated machines, is not a rating to be used in a frequently repeated duty cycle. It is intended as a measure of the machine's ability to handle occasional or emergency conditions.

In applications where the synchronous converter is known to be entirely satisfactory there is ordinarily little need for considering the motor generator. If synchronous converters have not been operated under the conditions contemplated or known to exist, consideration should be given to the probable effect of such disturbances as those to which all synchronous converters are inherently sensitive. The synchronous converter has been brought to its present high state of development in spite of certain fundamental limitations in its design possibilities and operating characteristics. As the motor generator is not subject to these same limitations, the same skill applied to its design will naturally produce a machine of inherently superior operating qualities. In general, the higher efficiency, and, the usually lower weight and space requirements, will decide in favor of the synchronous converter.

McGraw-Hill and Shaw Company Merge

Shaw and McGraw-Shaw Companies Become Divisions of McGraw-Hill

A CONSOLIDATION affecting two large publishing interests has been brought about by the merger of the McGraw-Hill Publishing Company, Inc., of New York, N. Y., and the A. W. Shaw Company of Chicago, Ill.

The Shaw organization publishes *The Magazine of Business, System* and *Industrial Distributor and Salesman,* while the McGraw-Hill organization is the publisher, either directly or through subsidiary and affiliated companies, of over twenty leading business papers, and of engineering and business books. Its magazines cover the electrical, mechanical, construction, mining and chemical fields, and include such well-known papers as *Electrical World, Engineering News-Record, Power, American Machinist, Engineering & Mining Journal, Chemical & Metallurgical Engineering* and *Radio Retailing.* The two companies have had a close relationship since last fall when they jointly formed the McGraw-Shaw Company, which publishes *Factory and Industrial Management* and *Industrial Engineering.*

Mr. A. W. Shaw will continue as chairman of the board and Mr. James H. McGraw will become president of the A. W. Shaw Company. Mr. Shaw will also become a director of the McGraw-Hill Publishing Company, Inc., and will continue as president of the McGraw-Shaw Company. Mr. Wheeler Sammons will become a director and member of the executive committee of the McGraw-Hill Publishing Company and senior vice-president and general manager of the A. W. Shaw division of the business, which will be known as the "A. W. Shaw Company, a division of the McGraw-Hill Publishing Company, Inc." The McGraw-Shaw Company will also be operated as a division of the McGraw-Hill Publishing Company.

Two reasons for the merger are stressed by the officers of the merging companies. The magazines of the two organizations are complementary in character. The Shaw papers cover business broadly, giving the business man an understanding of what is going on in all branches of trade, industry and finance. Their service is extensive in character. The McGraw-Hill service, on the other hand, is intensive. Its magazines give a highly specialized service to given major industries and to related industrial groups. Thus the consolidated companies serve the business man in both his general and special business interests. The second reason is the very evident economy and increased effectiveness of consolidated operation, enabling a superior service to be rendered to the whole sweep of American business.

QUESTIONS *Asked and Answered* *By Readers*

[HERE IS A PLACE *where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*]

Chord Factor of Concentric Winding

I shall appreciate it if some reader will answer the following question: A three-phase, six-pole induction motor stator has 72 slots and is wound with concentric coils placed in slots 1-16, 2-15, 3-14, 4-13, etc. What is the chord factor of this winding? In general, what is the proper method of calculating the chord factor of concentric or pyramidal coil windings? I have seen this factor calculated in two different ways, but the results obtained by the two methods do not coincide.

New Westminster, B. C., Canada — W. L. S.

* * * *

Winding Data For Armature of Rotary Converter

I have to rewind the armature of a Type EB-24, 3,600-r.p.m. Bodine rotary converter. The armature has been stripped, and I wish that some reader would give me the winding data on it. The armature has 15 slots and there are 32 bars in the commutator.

Chicago, Ill. — A. W.

* * * *

Pipe Templets for Various Angles of Turn

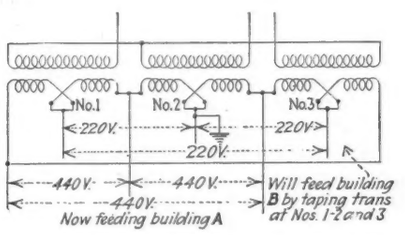
When recommendations were being considered for a rather extensive pipe installation in our plant, the question came up as to how we could bend the pipe so that the finished job would represent the suggested layout. Pipes of all sizes were to be bent and run at various angles and where the angle was critical, a welded joint was specified. We are prepared to do any welding job but we are unable to prepare the larger pipe sizes for the desired angle of bend. What we need most of all is a simple method of making templets for various bends from 15 deg. in pipe of from 6 to 36 in. diameter. Will readers who have had this practice show by example how a general rule can be used so that the desired results can be obtained?

Austin, Texas — L. P. A.

* * * *

Will This Ground Cause Trouble?

We have a bank of 440-volt transformers supplying power to Building A, which contains 440-volt equipment. Operations will soon be started in Building B, which has all 220-volt equipment. Our transformers are large enough to supply both buildings and we plan to connect them as shown in the sketch, tapping them at points *1*, *2*, and *3*, to obtain 220 volts. The local code



requires that we ground the neutral (No. 2 wire) on the 220-volt circuit, but the 440-volt circuit does not have to be grounded. I should like to know, (1), whether this scheme is practicable. (2) Will the 440-volt equipment in Building A be more likely to give trouble due to the grounding of the 220-volt service than if this circuit were not grounded? If so, what can we do about it?

Louisville, Ky. — W. R.

ANSWERS *Received to Questions Asked*

Slippage With V-Belt Drives

I should like to have readers tell me what their experience has been with parallel V-belt drives, using rubber fabric belts on short centers. What is the difference between their operating characteristics and those of a rope drive? Can you give me any information on the coefficient of friction and minimum arc of contact? I understand that these belts tend to creep and have no slip. What happens when one or two of the belts stretch? I shall be grateful for any information you can give me.
East Pittsburgh, Pa. H. G.

ANSWERING the question of H. G., the operation of rubber fabric belts is different from a rope drive in that the grooves are different. In the first place the most efficient angle for the groove for V-belt driving is 28 deg. included. This gives the maximum desirable positiveness with the minimum slip. It is also different from the continuous rope drive, in that the continuous rope drive has a take-up arrangement which insures the same tension on all ropes at the same time.

With too great a number of V belts, it is claimed detrimental differential driving will develop as soon as the belts stretch in a varying degree. This differential driving becomes detrimental and a factor seriously to be considered when the number of strands exceeds four or five.

Regarding the minimum arc of contact, this is a question that cannot be settled by a mere statement. The smaller the arc of contact with the ordinary V belt, the higher must be the initial tension. With the Link type of V belt, the theoretical arc of contact is increased when the belt is correctly run. All V belts, except the Link V, must be run under a more or less high initial tension. The Link V belt, on the other hand, must be run slack. Running this belt slack allows it to increase the theoretical arc of contact, due to the fact that the belt will hug down in over the circumference of the pulley from the point at which it leaves it. So it is generally possible when using the Link V belt to start with a theoretical arc of contact even as low as 128 deg., but through running the belt slack, it makes an actual operating arc of contact of over 140 deg.

On some recent tests that I have made in some of the textile mills in the South, I find that in the matter of creep or slip, a leather V belt in a 28 deg. angle groove will creep or slip to an extent of 0.3 per cent minimum to 0.6 per cent maximum, or has an efficiency as far as slip is concerned of from 99.4 per cent to 99.7 per cent. These particular slip calculations were made on 28-deg. angle grooved sheaves, 7 in. O.D. to 9.75 in. O.D. on 10 in. centers, transmitting 7½ hp., and with single and double strand drives.

With a multiple strand drive, having not more than four strands of belt, it will be found that with the solid or block type of belt, the matter of stretch will fluctuate; that is, one or two belts may carry the majority of the load and elongate when the other two or three will begin to carry their share of the load, while the one or two that have stretched will loaf. This is rather theoretical, but it is a fact that these loafing belts will tend to drag and the other belts will do their work until they reach the same length, when all will operate equally.

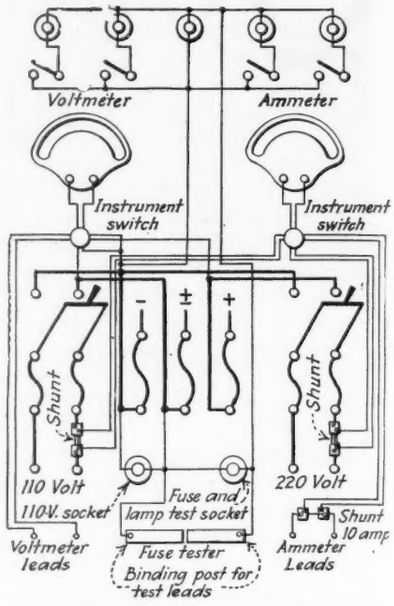
With the Link type of belt, this factor does not have to be considered, for the belts are run always slack, and the matter of stretch has no bearing on the efficiency of the drive. As there is practically no initial tension, there is practically no stretch. G. A. BARNARD.
Worcester, Mass.

Test Panel for Repair Shop

I wish some reader would give me the layout and description of a suitable test panel for our repair shop. We use 220 and 110 volts direct current and I wish to be able to test and run 220-volt direct current motors up to 7½ hp. rating, by plugging into the board. For testing we will, of course, need a volt and an ammeter. I should also like to install a receptacle for a 110-volt electric iron and a 110-volt test line. I should like to be able to cut the voltage down on this, or another test line, by putting lamps or heating elements in the circuit.
Chicago, Ill. F. J. C.

COMPLYING with F.J.C.'s request, I am describing a 110/220-volt test panel that I believe will answer his purpose.

This test board has a 100-amp. main line fuse and two 60-amp. fused switches for the 110- and 220-volt circuits. An instrument switch is placed in the voltmeter circuit so that readings can be taken on the 110- and 220-volt lines and a spare pair of leads is brought out at the bottom of the board for testing. These test leads will be found useful in testing high resistances for open circuits, measuring the drop across coils for comparison, and also for measuring resistance by the voltmeter method. For the latter test, if the resistance of the voltmeter is not marked on the scale it can easily be obtained from the manufacturer.



WIRING diagram of panel for testing d.c. equipment.

* * * *

The same type of instrument switch used in connection with the voltmeter is placed in the ammeter circuit for measuring the current in the 110- and 220-volt lines. In addition to this, a spare pair of leads is brought out at the bottom of the board through a 10-amp. shunt. These leads will be found useful for checking field current, measuring the current used by small appliances and also for the ammeter method of testing armatures. For motors up to 7½-hp. a 50-amp. shunt should be used in the 220-volt circuit. For the 110-volt circuit F.J.C. will have to determine the maximum current needed and install a suitable shunt.

In installing the ammeter switch care must be taken to have all connections clean and tight and the wires from the meter to the switch as short as possible.

List of Materials for Testing Panel

1	3 x 4 ft. ebony asbestos panel, 1 in. thick	$18.00
1	Weston Model 271 voltmeter, 0-300 volts	30.00
1	Weston Model 271 ammeter with external shunt, 0-50 amp	23.00
2	Weston switchboard shunts	10.00
7	Paiste concealed sockets No. 14,000	1.40
2	Trumbull No. 4462, d.p.s.t. fused-bottom, 60-amp., 250-volt, back-connected knife switches	6.00
6	Trumbull No. 1084, 100-amp. fuse holders, back-connected	6.00
4	Trumbull No. 783, s.p.s.t. 25-amp., back-connected knife switches	1.20
2	Westinghouse No. 519115, four-circuit voltmeter switches with two keys, covers and screws	30.00
10	Heavy binding posts	2.50
10	⅛ x 1 in. copper	.10
		$128.20

ANSWERS *Received to Questions Asked*

If this is done the calibration of the instrument will not be changed.

The plug fuse and lamp-testing socket is constructed by taking the shell out of the socket, hammering the threads out over a suitable mandrel and putting fiber washers under the bottom contact to raise it about ½ in. This makes it possible to insert fuses or lamps into the socket for test without screwing them in and out.

The cartridge fuse tester consists of two pieces of copper ⅛ x 1 x 5 in. These are placed on the board with a small air gap between the ends. On the ends of the test plate are fastened two binding posts for the test leads. Be careful to bring the neutral wire to the test plate and run the other wire through the lamps. If this is done you will not have a short if the leads are accidentally grounded.

In the test lead circuit there are five sockets; one is permanently connected; the others can be cut in or out by means of single-pole switches.

On this board I used binding posts instead of plugs and jacks as I find they are more serviceable. The plugs and jacks always give more or less trouble by coming loose or the leads breaking. With the binding posts any odd lengths of wire in the shop can be used for test leads.

The list of materials for this board, with the approximate cost, is given in the accompanying table on the preceding page.

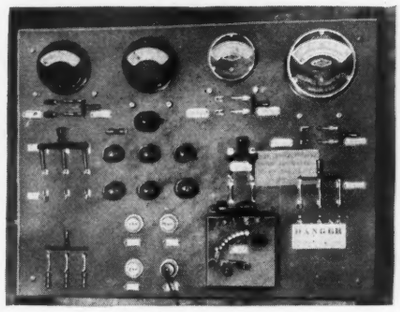
I used the Weston Model 271 instruments for this job as they have long, open scales and are easily read at a distance.

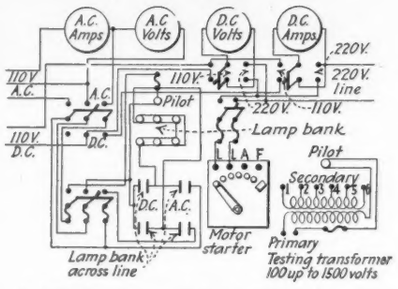
If you wish to cut down on the cost of the panel you can use cheaper instruments and eliminate the instrument switches by placing the ammeter shunt in the negative main so as to read on both circuits. In the voltmeter circuit you can use a d.p.d.t. battery switch to change over from the 110- to the 220-volt circuit. This, of course, will eliminate the ammeter and voltmeter test leads. WM. H. FREDRICKSON.
Elizabeth, N. J.

IN ANSWER to F.J.C.'s request, the illustrations show the layout and wiring diagram of a switchboard we have built for testing motors and armatures that are being repaired. As will be noted, we have designed this board for both a.c. and d.c. testing. The testing transformer shown in the wiring diagram has been added since the photograph was taken, and was built from a description in Braymer and Roe's "Rewinding Small Motors" (McGraw-Hill Book Company).

Of course, if alternating current is not available, the a.c. part of the board can be left out.

A 220-volt starter is used instead of plugging in, as it will be found that a starter can be used to operate on no





LAYOUT of panel for testing a.c. and d.c. equipment. The testing panel is connected up as shown here.

* * * *

load various sizes of motors, both larger and smaller than the rated capacity of the starter. A starter of about 4-hp. rating should meet F.J.C.'s requirements.

There is a double-throw change-over switch in both the ammeter and voltmeter circuits so that readings may be obtained on both the 110- and 220-volt lines. If both lines are needed at the same time a connection will have to be made across one side of the change-over switch.

The lampbank can be used as a current-limiting device for millivoltmeter tests on armatures or for any other purpose. A receptacle is provided for use with the lampbank, and another is connected straight across the line. JOSEPH RONA.
Pullman, Ill.

Grounding When Loading Tank Cars

What is the best and safest way to ground the loading pipes and tank cars to prevent static discharges when loading benzol or other highly inflammable liquids? We attach a good ground wire to the end of the loading pipe which enters the dome of the tank car. The track is grounded but not bonded. Should the rails be bonded? Perhaps some reader can give us his method.
Chicago, Ill. J. O. C.

REFERRING to J. O. C.'s question, if the track were used for a ground I would emphatically insist on bonding—and then be in doubt as to the effectiveness of the track as a ground, for this would be determined largely by the weather or climatic conditions. It would be most effective as a ground during wet seasons.

I assume that the loading position is a permanent one in which event a permanent ground should be installed. It could consist of a copper plate buried deeply enough to insure contact with permanently moist earth, with a wire connector soldered to it to receive the ground wire.

A good ground can also be made by driving three fair-sized pipes or copper rods into permanently moist earth. For safety's sake, more than one ground should be used.

I would seriously recommend periodic tests of any grounds used, for they vary in effectiveness with climatic conditions, the condition of the electrodes, and so on.

If a metallic hose is used to convey the liquid it should touch the receiving tank; there should not be an air gap existing between the end of the hose and the receiving vessel, as the danger of fire or explosion from a static spark is increased.

I would have no faith in a ground through the rails unless they were effectively grounded and thoroughly bonded. E. J. MORRISSEY.
Ass't Chief Engineer.
Western United Gas & Electric Company, Aurora, Ill.

Waterproofing Concrete Wall

During the past winter the paint peeled off the interior of one of the outside concrete walls of the building. Can any treatment be given to the exterior or interior surface which will prevent this? If any other reader has overcome a similar problem, I would appreciate his solution.
Chicago, Ill. E. D. F.

REFERRING to E. D. F.'s question, I want to tell the experience I had with a concrete wall about a year and a half ago. In my case the wall of the building faced toward a wall tank placed on a steel tower. The tank overflowed frequently and the water would seep through the wall, causing the paint to peel; then the concrete would dry with a white powdery substance on it. Different kinds of paint were tried but we could not get anything to adhere to the wall.

After about six months of trying various things I obtained a waterproof material called Bondex, manufactured by The Reardon Co., St. Louis, Mo., and applied it to the wall. I have had no trouble since then and the wall shows absolutely no signs of seepage or discoloring.

Before applying this material I had the wall well hosed, washed with hot water, and brushed until there was no sign of loose material and the surface was perfectly clean. The Bondex was not applied until the wall was practically dry.

It can be used for both interior and exterior surfaces of walls.
Portland, Ore. M. C. PARKER.

AROUND THE WORKS

THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

Trouble in Phasing Out

FROM time to time various articles appear in the *Industrial Engineering* regarding procedure in phasing out generators.

As a rule this test is a simple one, however, in our particular case an unusual feature presented itself and in this respect I am sure other unusual problems in this connection would interest readers.

Our generator which we were phasing out was rated 20,000 kw., at 80 per cent power factor. This machine was brought up to proper speed and voltage and the switch was closed.

Instead of the lights, which were of the carbon filament type acting as they should they assumed a brilliancy that indicated nothing as far as phasing out was concerned.

The two top groups seemed to appear more brilliant than they should but their brilliance fluctuated with the synchroscope with an apparent time lag from maximum brilliancy on group one to maximum brilliancy on group two while group three appeared to have about half voltage impressed on the filament and no variation apparent in the redness of the filament, or on a voltmeter that checked their voltage.

A voltmeter test to ground was taken at the lights but no deflection was obtained. Connections were checked and transformers were tested, also the code of the cable was tested for continuity, in addition, the voltage at the potential transformer secondaries showed normal, but still our conditions persisted. All this happened, however, immediately following a severe electrical storm.

It was then decided to test our bus for grounds as this was new construction work in which the neutral ground was as yet not cut in service. With the bus at bus potential our test connections were made and the result showed full deflection from phase *A-B* to ground, but *C* showed no deflection or an indication of a dead ground which was later located at the bushing of a transformer that was supplying power to a large industrial works.

When this was cleared up our synchroscope and phasing lights registered properly.

Our neutral ground being in service now we anticipate no more trouble on this order, the unusual experience is merely another incident for "The Book."

E. J. MORRISSEY.

Asst. Chief Engineer,
Western United Gas and Elec. Company,
Aurora, Ill.

Arc Welded Coat Rack

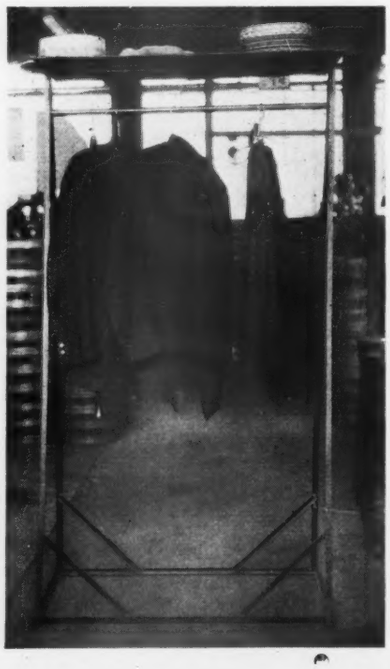
IN SHOPS where arc welding is used extensively, various devices built by operators in their spare time are always found. The illustration shows a coat rack used by workmen in the welding department of The Lincoln Electric Company, which represents the sort of equipment that operators build in their spare time.

Perhaps half an hour was spent on this coat rack, which serves its purpose just as well as one far more expensive. Welder operators are either especially ingenious workmen in utilizing scrap steel or else it is the arc welding process which encourages spare time construction of this sort.

Work benches which formerly required work orders on other departments are often constructed of short ends of steel which were laying around the department. Such benches have the advantage of extreme rigidity and low cost. It is a simple matter for an operator to weld up jigs and fixtures at a cost figure which permits discarding them after they have served their purpose.

* * * *

COAT RACK built by operators in spare time.



Minimizing Delays with Spare Fuses

DELAYS in our plant from blown fuses are very expensive due to the time lost in calling an electrician, finding the blown fuse and replacing it. We minimized these delays in the following manner.

A good many old fuse clips of various sizes were taken out of a junk heap, reclaimed and mounted on the inside walls of cabinets and inclosed switches. Complete sets of fuses were then placed in the clips for use when needed. If the trouble-shooter does not have a tester at hand, all that is necessary to do is, pull all fuses in the dead circuit and put in good ones as they are on hand.

J. D.

Chief Electrician,
Agar Packing & Provision Company,
Chicago, Ill.

Condenser Across Terminals Reduces Lamp Breakage

A FEW months ago I installed several flood lights on the roof of an industrial plant. These lights gave such satisfactory results that the management decided to install a 250-watt 12-in. reflector floodlight on the roof of a locomotive crane and operate it from the generator which supplied power to the lifting magnet.

After the light had been installed and connected to the generator, it remained in service that evening from 6 until 9 o'clock, when the lamp burned out. The next day I placed $\frac{3}{4}$-in. diameter coil springs made of No. 9 steel wire under and above the $\frac{1}{4}$-in. steel plate on which the light was mounted. The reason for this was to eliminate the vibration from the lamp, when the hoist engine or travel was running. We were

under the impression that the vibration had caused the lamp to burn out, but the next night the bulb burned out again after 4-hr. use.

The following day I returned to the floodlight installation again. After much discussion we decided that the light was burning out from an electrical cause and this was substantiated in finding the socket shorted and burned. The voltage of the magnet generator was only 200 so it was almost an impossibility for it to jump the distance necessary to short across the socket terminals. However, the filament in the lamp was entirely destroyed. Our conclusion was, that the kick-back from the lifting magnet when the circuit was opened to drop material, was not absorbed quick enough by the resistance supplied for that purpose to prevent a potential high enough to leak or jump across the space between the base contact of the socket and the screw shell of the lamp. Or, the engineer may have been slow about throwing the control lever to the reversing circuit causing the lamp to absorb the shock.

It has been my experience that any quickly reversed circuit has induced in it, a high potential immediately as the break and reversal is made. A severe jolt will be felt immediately upon the break. In fact, I know of a d.c. motor which operates a planer and the voltage induced upon the break and reversal makes it almost impossible to insulate this motor from the ground. This particular motor has a high resistance and, also, a condenser across its field terminals. Knowing that the company operating this planer motor always kept a spare condenser in stock we made arrangements to replace their spare and used it across the light terminals. However, placing it inside the crane cab. Evidently, this was the correct solution of the trouble because the light has been in service for several months and only ordinary bulb renewals have been necessary. GRADY H. EMERSON.

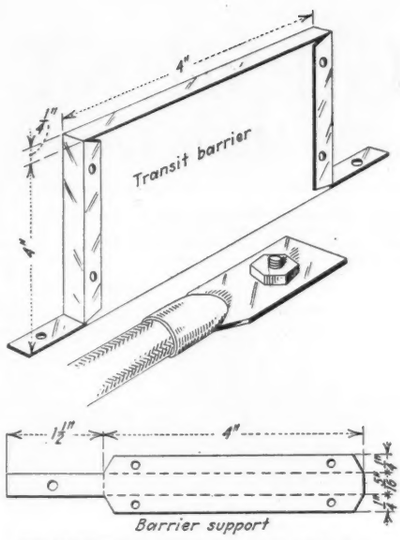
Birmingham, Ala.

Transite Barrier Support for Inclosed Panel

RECENTLY the writer placed in service a three-phase 200-amp. remote control contactor, controlling an important circuit and to avoid excessive voltage drop, heavier wire was used on the circuit than was customary. This necessitated using larger lugs than those supplied by the manufacturer of the contactor and due to the studs being spaced on 2-in. centers there was danger of trouble from flash overs or short circuits between the lugs. For this reason it was decided to insure against delays and expense by placing barriers between the lugs.

Transite barriers were made—4x4x$\frac{1}{4}$ in. and fastened to the slate base of the contactor by means of the support shown.

These supports were made from 18 gage galvanized iron, drilled and bent or shaped as shown. It was necessary



TRANSITE BARRIER assembly between lugs on slate panel. Support layout is shown marked for holes and bending along dotted lines.

* * * *

to drill only 4 holes through the slate base and this was done without the trouble and delay of removing the contactor panel from the steel box.

CHAS. A. PETERSON.

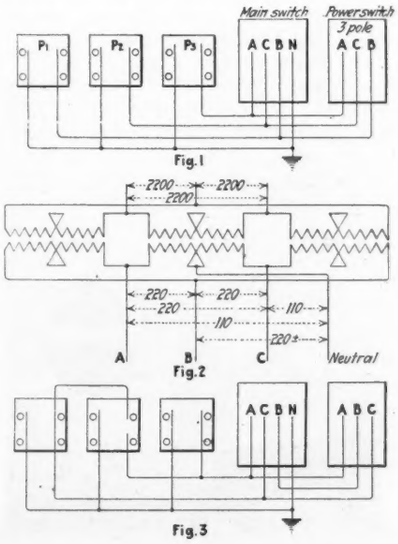
Chief Electrician,
Fairbanks Exploration Company,
Fairbanks, Alaska.

Reconnecting Lighting Layout for Changed Service

IN DESIGNING the layout for power and lighting on a new job recently, the local power company directed that we put in a three-phase four-wire service to feed both power and lighting circuits.

Inasmuch as we installed several three, and four-wire services in the last two or three months, we did not think much of the request but put in what they specified.

The power load consisted of two 15-hp., three-phase, 220-volt induction motors driving two ammonia compressors and two 1½-hp., three-phase, 220-volt induction motors driving two brine pumps. The lighting load of 70 amp. was distributed between twelve circuits in the building.



In order to balance the lighting on the three-phase mains, we put in three 4-circuit residence panels and fed the P_1 panel from phase A and the neutral; P_2 panel from phase B and the neutral, and P_3 panel from phase C and the neutral.

The three-phase motors were connected across the phase wires as shown in Fig. 1 of the illustration.

This arrangement made a nicely balanced layout and we anticipated no trouble, but when the meters were installed and the power turned on, we got a complaint that the lamps on four circuits kept burning out, so an electrician was sent to shoot trouble and more especially, to look for incorrect connections in the panel boxes. In a short time he reported that he could find no trouble, for apparently all connections were correct.

In going to the job, we checked over the connections again, but could not find anything wrong except high voltage on one phase.

We then pulled the main switch and again tested with a test lamp, from the phase wires to the conduit, failing to find the trouble. Using a voltmeter I found by test, 110 volts between phases A and C to neutral but approximately 220 volts between phase B and neutral. This definitely placed the trouble outside of the building, so we went out to look at the transformers, and found two 10-kva. units with a 15-kva. transformer between them, but more important, the power company had run three-phase, three-wire primaries and connected the bank in delta, instead of running three-phase, four-wire primaries and connecting star. For a neutral, they had taken a tap from the middle point of the 15-kva. unit. This gave the connections and voltages found by test as shown in Fig. 2.

The power company when notified, advised that they had found it impossible to run three-phase, four-wire primaries to this plant. It was only from the underground system downtown that such service was furnished and all customers outside of this system would be served from three-phase. three-wire primaries. It was a mistake in the first place to put a three-phase, four-wire service into that building.

The only thing for us to do was to take out the three-phase, four-wire meter from the lighting circuit and feed it single-phase 110-220 volt, from phases A. C, and the neutral, splitting phase B as shown in Fig. 3 between the 220-volt lines. Since this changeover, we have had no trouble with lamps burning out. H. G. MILLICAN.

Foreman,
Miami Electric Service Company,
Miami, Florida.

* * * *

METHOD OF RECONNECTING three-phase, four-wire service to a three-wire power and lighting layout.

NEW EQUIPMENT

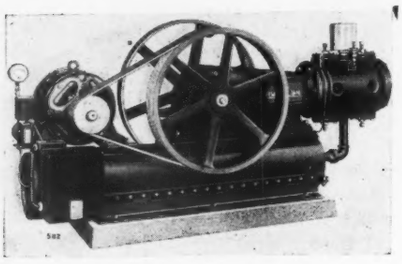
For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Single-Stage Compressor Unit

A SEMI-PORTABLE, single-stage, double-acting, belt-driven air compressor unit has been brought out by the Pennsylvania Pump & Compressor Company, Easton, Pa. It is completely self-contained, a motor, starter, multiple-belt drive, air receiver, air filter, and automatic start and stop control constituting the unit, which is intended for use in industrial plants and other places where the demands for air are comparatively limited.

The air cylinders and all working parts are automatically lubricated. The compressor is equipped with Pennsylvania air-cushioned valves, and contains all of the other features that are built into this company's line of stand-



Pennsylvania Semi-Portable, Single-Stage Compressor Unit

ard compressors. This unit is driven by a 10-hp., high-torque motor.

The piston displacement is 65 cu.ft. of free air. The automatic pressure control operates between 85 and 125 lb. per sq.in. The over-all dimensions of the unit are: length, 6 ft. 6 in., width, 2 ft. 4 in., weight, 1,380 lb.

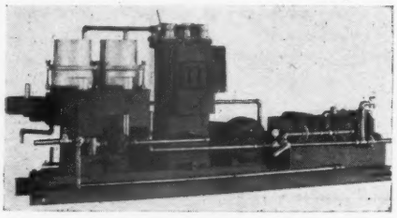
Oil Purifying Machine

THE Hydroil Corporation, Lebanon, Ind., has placed on the market a new, large-capacity oil purifying machine, designated as F-100.

In basic principle, it is similar to the smaller Hydroil machine, but uses twin bowls in place of the single bowl.

The oil, before it passes into the centrifugal bowls, passes through a heater, which raises the temperature to the point at which the impurities are most easily separated out.

After the oil leaves the bowl, it passes through a pressure settling tank, where all air is removed. It then passes through a twin filter press, so designed that one-half of the press only is operation at any one time. By turning a valve, the press that is being used can be cut out and the oil run through the unused half of the filter, enabling the operator to replace the filter papers of the press that was in use, without stopping the machine.



Hydroil F-100 Oil Purifying Machine

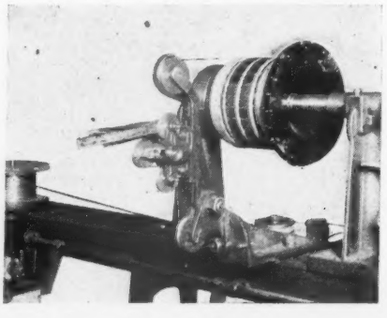
After the oil has passed through the filter press, it can be passed through a continuous test chamber. The test chamber can be so connected with a relay and bypass valve that only oil of the desired dielectric strength can pass through to the switch tank, transformer or storage tank.

Banding Wire Tension Indicator

THE General Electric Company, Schenectady, N. Y., has developed a device for use in repairing railway and industrial haulage motor armatures, to indicate the exact tension in pounds that is applied to the steel banding wire. By its use, it is claimed that the binding wire will not be stressed beyond the elastic limit of the steel, and will be kept under uniform tension during the banding process.

The indicator can be applied to practically any type of armature-banding machine. It is equipped with a rotary dial that can be turned to any position by loosening a nut and setting the pointer at zero, so that the scale may be read at any angle. The indicator dial is graduated from zero to 500 lb. allowing the use of any size of banding wire within the range of the machine.

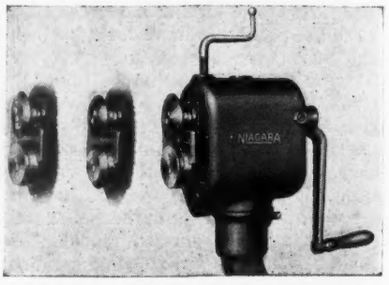
General Electric Tension Indicator for Banding Wire



Sheet Metal Working Machine

THE Niagara Machine & Tool Works, Buffalo, N. Y., have recently put on the market the No. 147-C Niagara heavy combination bench machine for turning, wiring and burring operations on sheet metal.

This machine is arranged with back gearing and will handle soft steel up to 18 gage. The faces are made of high-grade steel, hardened and polished and are easily removed and interchanged for burring, turning, or wiring operations on sheet metal. This bench machine is a "big brother" to the No. 131-C machine which was designed to handle the lighter gages of metal.



Niagara No. 147-C Heavy Combination Bench Machine

The machine is furnished complete with one pair of burring faces, one pair of turning faces, one pair of wiring faces, gage, wrench and heavy bench stand, or as a single-purpose machine with only one pair of either rolls desired.

Magnetic Switch

A NEW line of magnetic a.c. motor starting switches has been announced by the Trumbull Electric Manufacturing Company, Plainville, Conn. These switches are available in ratings of 1 to 15 hp., 110 to 550 volts, two- and three-phase.

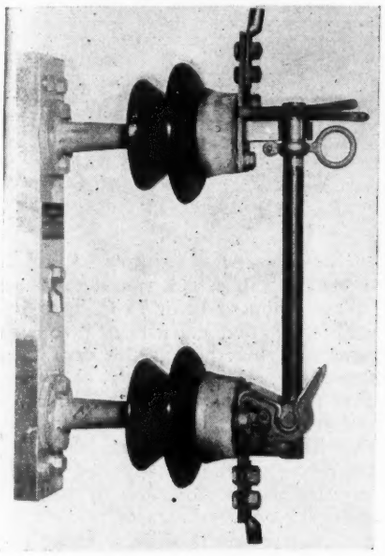
Among the advantages claimed for these new switches is unusually high current-interrupting capacity. This feature is secured by the use of moving contacts that bridge the gap between the set of stationary contacts, and eliminate flexible connections. In addition, these contacts are self-aligning and self-cleaning, and can readily be renewed when necessary.

Overload and undervoltage protection are provided by thermal relays which control the circuit of the magnet that operates the switch. These relays are entirely enclosed to protect them from damage.

High-Voltage Fusible Cutout

A NEW type of high-voltage fusible cut out, designated as Type EF-1, has recently been introduced by the General Electric Company, Schenectady, N. Y., for outdoor service. It is available for voltages of 7,500 to 73,000 volts, and in current ratings from that suitable for use with a potential transformer to 100 amp. The new cutout not only provides a spring-expulsion, circuit- breaking feature, but also serves as a disconnecting switch. It is assembled on cemented cap and pin type insulators and is designed for vertical mounting.

The high-voltage fuse used consists of a treated fiber tube with a metal ferrule at each end. At the top of the tube a very short fuse link is connected in



General Electric Type EF-1 Combined Fuse and Disconnecting Switch

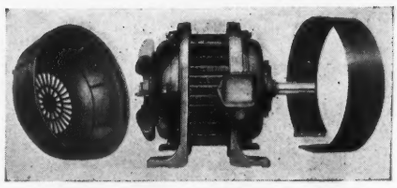
series with a flexible copper cable held in tension by a compressed spring located at the bottom of the tube. When a load sufficient to fuse the link is placed on the cutout, the spring dissipates its energy in pulling the copper cable from the live contact and ejecting it from the bottom of the tube. The explosive pressure generated within the casing by the vaporizing of the link metal assists in the ejecting process.

After operation, the tube and link must be replaced by a new, factory-filled unit.

Enclosed Motor

AN AIR-JACKETED motor for location where dust, fumes and moisture are present in large quantities has been developed by the Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis. The entire motor is surrounded by a jacket open at both ends with fan blades on a shaft extension between the sealed motor and its outer jacket. The only clearance between the rotating and stationary parts of the motor is in the grease-packed bearing housing.

The motors are new in external construction only; no changes have been made in the electrical features. The frame housing, the states and all bearings are substantially airtight. The end shield is made of cast iron, and has a grating that protects the fan and admits ventilating air. The center shield is heavy sheet steel. The fan is of one-piece construction. The conduit box is mountable in four position.



Wagner Type CP Air-Jacketed Squirrel-Cage Motor

Double-row ball bearings are used in these motors; they are self-aligning in one end plate and deep groove in the other to take end thrust. The bearings are grease-lubricated and sealed in dust-proof housings.

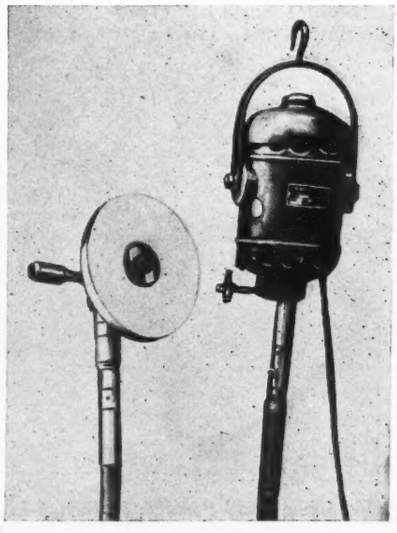
Single-phase repulsion-induction motors can be furnished in sizes from 1 to 20 hp. and polyphase squirrel-cage motors in sizes from 2 to 30 hp. These motors are designed for a temperature rise not to exceed 50 degrees centigrade and are said to meet all A.I.E.E. and N.E.L.A. standards.

Suspended Motor Unit

RECENT development of the direct-connected suspended unit shown in the illustration has been announced by the Stow Manufacturing Company, Inc., Binghamton, N. Y. This unit comprises a ball bearing 1-hp. motor fitted with a flexible shaft. The standard length of shaft for this unit is 6 ft. long, although other lengths will be furnished on request.

This unit is intended to drive rotary files, sanding disks, grinding wheels and the like, either directly or through an angle head, as conditions require.

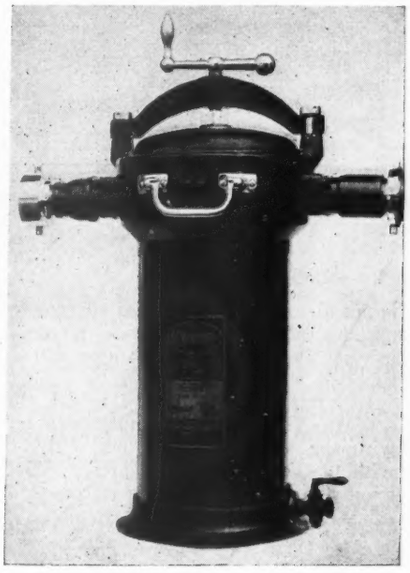
Stow Direct-Connected Suspended Unit



Firefighting Equipment

WHAT is known as Model 401 Phomene Accumulator has been brought out by the Pyrene Manufacturing Company, 560 Belmont Ave., Newark, N. J. This device is designed to supply foam consisting of bubbles filled with carbon dioxide gas for fighting oil and other fires that cannot be extinguished by water.

The accumulator is charged by placing in it a container of foam-making powder. A water connection is made to the inlet shown at the left. When the device is put into operation, either manually or automatically, the water entering the accumulator mixes with the powder, whereupon a chemical action takes place and a mixture of foam and water is discharged from the outlet at



Pyrene Model 401 Phomene Accumulator

the right. More than 280 gal. of foam can be obtained from one container of powder. The time of discharge is from $1\frac{1}{2}$ to $1\frac{3}{4}$ minutes.

For proper operation, the model 401 accumlator requires an applied water pressure of 30 lb. per sq.in. or more. If desired, this accumulator can be supplied for automatic or semi-automatic operation, or for portable use.

Lighting Units

DESIGNED for illuminating straight and rounded surfaces from a grazing angle, a new style of special lighting unit known as the Projectolite has been developed by the Benjamin Electric Manufacturing Company, 120-128 South Sangamon St., Chicago, Ill.

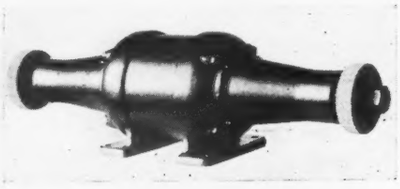
In this new fixture the powerful floodlight beam is flattened and broadened by means of a special lense, so as to direct a greater part of the light to points farthest from the lighting source, and a correspondingly smaller portion to the points nearest the reflector. Consequently, it is claimed that this process of spreading the light rays results in an even illumination over the entire surface.

Grinders

GRINDERS for use on high frequency current have been announced by Forbes & Myers, 172 Union St., Worcester, Mass.

The illustration shows model No. 204, 5,400 r.p.m., double end, ¾ hp., the grinding wheel 3 in. to 4 in., for operation on 180 cycle current. The spindle is ¾ in. in diameter at the wheels, and 23 in. long. Four ball bearings are used, with a large reservoir for grease between the two bearings in each arm. The wheels are held between flanges 2 in. in diameter. The motor is of the squirrel cage induction type, fully enclosed, in appearance like the usual induction motor for 1,800 or 3,600 r.p.m., except for the slight alterations in the winding.

It is also stated that where the plant



Forbes & Myers Grinder for High-Frequency Current

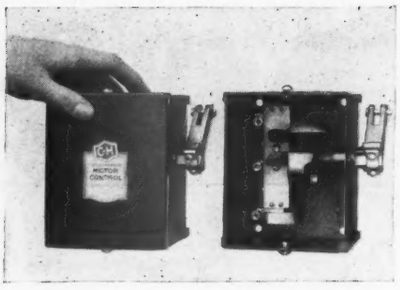
is not already equipped with current for the desired speed or speeds, a simple inexpensive frequency changer can be supplied with the grinders.

In addition to the above model, this company is offering similar grinders with the spindle on one end only, or without the supporting arm. These grinders are made in sizes from ¼ to 2 hp. for any high frequency current.

Master Switch

A NEW switch, designed especially for splined shaft or shipper rod operation is announced by the Cutler-Hammer Manufacturing Company, 12th and St. Paul Aves., Milwaukee, Wis. This switch, it is claimed, is for use as a pilot circuit control device on lathes, textile machinery, and other equipment where starting and stopping of a machine is to be governed by a splined shaft, shipper rod, or similar device. Low-voltage protection is one of the important features also claimed for this switch.

Some of the more outstanding features are; non-stubbing contact; shear pin to protect mechanism; few parts and simple construction, operating lever can be placed in any one of four operating positions, 90 deg. apart, to suit any installation requirements; long steel tubes —bronze, main bearings with oil holes, small size, fully inclosed in heavy steel case, cover can be removed by loosening only two screws. The switch is designed especially for three-wire control, but can also be used for two-wire control on pilot circuit up to 550 volts. This switch may be mounted at the end of the machine, the splined shaft or shipper rod running the length of the



Cutler-Hammer Manufacturing Company Shipper Rod Operated Switch

machine. In operation, moving the switch to the "on" position starts the motor the same as pressing the "on" button in the ordinary pushbutton station.

The mechanism is protected against damage by a shearpin. This shearpin fastens the operating mechanism to the main shaft and any undue strain on the mechanism causes the pin to shear, making the switch inoperative. Extra shearpins can be carried in stock and inserted after the trouble has been cleared.

Hand Portable Inspection Light

A NEW hand portable light designed especially for very close inspection work such as is required in automobile spraying and finishing plants, furniture finishing plants, rug factories, weaving plants and similar locations, where the inspection requirements are unusually rigid, is announced by the Benjamin Electric Manufacturing Company, 128 South Sangamon Street, Chicago, Ill.

When held close to the surface to be illuminated, this light provides a bright spot of illumination of sufficient intensity to show up any imperfection in finish or texture.

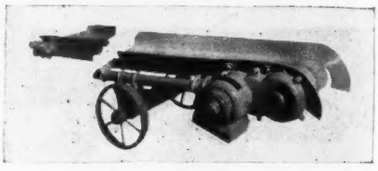
This portable light is of a handy size, according to the manufacturer, weighs only 2½ lb., and is very easily operated. A conveniently located thumb switch in the handle automatically breaks the circuit when the thumb is removed, thereby preventing waste of current as well as the time of the inspector that is usually

Benjamin Hand Portable Inspection-Lite

spent in switching a portable light on and off. The light consists of a heavy gage aluminum reflector with a highly polished inside reflecting surface and a sand blasted exterior, producing a satin aluminum finish. A glass cover, smooth outside and sand blasted inside permits of easy cleaning, it is claimed. A felt gasket between the glass cover and the reflector provides a dust-tight joint.

Portable Conveyor

DEVELOPMENT of a new portable conveyor known as the Jax has been announced by the Link-Belt Company, 910 South Michigan Ave., Chicago, Ill. It is designed for handling packages, bags, coal, etc., into or out of cars, and like service.



Link-Belt Jax Portable Conveyor

This conveyor consists essentially of an endless rubber belt running over two pulleys mounted 12 or 15 ft. apart on a framework that consists of two heavy pipes tied together at the ends. The conveyor rests on a pair of agricultural-type wheels which are movable to practically any point along the frame. The height of the discharge point of the conveyor can be adjusted by moving the wheels forward or backward along the conveyor frame. The wheels are also provided with a vertical adjustment for three positions.

One of the features of this conveyor is the comparatively light weight; a 12-ft. conveyor, complete with motor, weighs 640 lb. and the 15-ft. conveyor, with motor, weighs 710 lb.

Bus Support

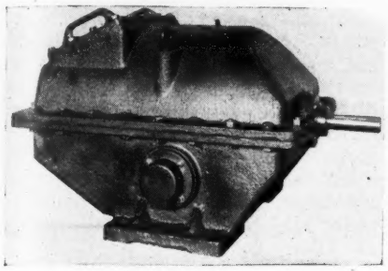
THE Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has developed a new line of busbar supports known as the Modified Hollow Square type. These supports consist of heat-treated aluminum alloy clamps which are insulated from the standard 1¼-in. pipe of the mounting support by means of high-grade micarta tubes. The bus support is designed for 4 x ¼-in. busbars and for a maximum of 4,000 volts, alternating or direct current.

The support may be adjusted to carry from 1 to 12 bars. This feature allows the bus to be tapered as feeders are tapped off, and permits the easy installation of additional bus copper to provide for an increasing load. The hollow square arrangement of bars minimizes the influence of both skin effect and proximity effect, and will permit the copper to be used at its maximum efficiency.

Motors for Explosive Atmospheres

A LINE of both alternating and direct current motors, built for application where explosive gases, fumes or dust are present, is announced by the General Electric Company, Schenectady, N. Y. These motors have been approved (as a result of tests) by the Underwriters' Laboratories for operation under such conditions, it is said. The motors bear the General Electric designation "Class BU Form JA" and are a totally enclosed design.

The object of the special construction is to reduce the danger that heat, generated inside the apparatus from any cause whatever—whether it be sparking or explosion—will be transmitted to the outside in such intensity as to ignite any gases surrounding the equipment.



General Electric Enclosed Motor for Use in Explosive Atmospheres

A two-piece, cast iron exterior is provided, heavy enough to withstand the pressure of an internal explosion, and with flange joints sufficiently wide to cool the flame of any explosion. No gaskets are used as it is not intended that the motor should be gas tight.

The alternating-current motors are available in single phase ratings up to 3 hp., and, in poly-phase rating, up to 15 hp., at standard voltages and the more popular speeds. The direct-current motors may be either shunt or compound wound with the hp. ratings from $\frac{3}{8}$ to 5 hp., also at the standard speeds and voltages.

All of these motors, either a.c. or d.c. type, are designed to operate within a temperature rise of 55 deg. C., the standard for enclosed motors, it is added.

Babbitt Melting Furnace

ANNOUNCEMENT is made by the Rowell Manufacturing Company, Appleton, Wis., of its new furnace for melting babbitts and other non-ferrous metals. According to the manufacturer, this furnace is designed especially for the use of industrial maintenance departments.

The body of the furnace is a riveted steel jacket with a 1 in. lining of heat insulation. The base is cast iron and is equipped with four roller bearing casters so that the furnace may be moved about as desired, for either floor or bench work. The melting pot is of heavy cast iron and is equipped with a bottom door outlet having an internal valve device, operated by a handwheel at the top of the furnace. The bottom door feature, it is claimed, permits the dirt and other impurities remaining on the surface to protect the metal beneath from oxidation, instead of being removed as is necessary in dipping of the metal from the furnaces which do not have this feature.

Air circulating chambers on the top of the furnace, it is added, give a better circulation of heat around the entire melting pot. This eliminates freezing at the top and upper surfaces of the pot. The furnace is especially designed for burning charcoal, but a gas burner has also been designed for use with this equipment. The melting pot is 9 in. in diam. and 7 in. deep, and has approximately 120 lb. lead capacity. The dimensions are 29 in. high overall and occupies a floor space of approximately 20 sq.in.

Wiring Devices

IN ORDER to meet the demand for lamp holders taking a lamp smaller than the medium base, yet larger than the candelabra size to fit the new S-11 bulb lamp, the Intermediate line of wiring devices has been produced by the Bryant Electric Company, Bridgeport, Conn.

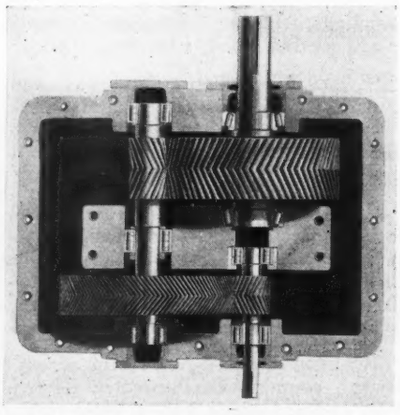
Sockets with intermediate screw shells can now be secured in the following styles: brass shell, key, keyless, and pull sockets; composition candle pull sockets, Templus pendant weatherproof sockets, porcelain keyless candle sockets, and sign receptacles.

In addition, a new Bryant line of intermediate-size receptacles is particularly adapted for surface wiring and for metal signs. The new series includes an adapter from standard to intermediate base.

Roller Bearing Herringbone Speed Reducer

THE B. O. James Manufacturing Company, Chicago, makers of cut gearing and speed reducing transmissions, announce the new James generated continuous-tooth herringbone speed reducer, made in both single and double types.

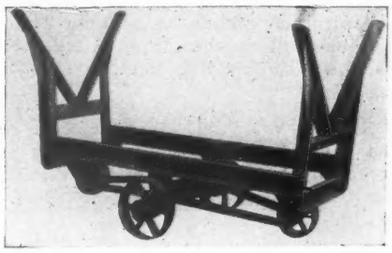
It is stated that these reducers are new and that they are now fully equipped with anti-friction Hyatt roller bearings on the high, intermediate, and slow-speed pinion shaft, and Timken roller bearings on the slow-speed shaft. This latest addition in bearings has resulted in an added efficiency of these units, it is claimed.



James Double Type Herringbone Speed Reducer Equipped with Hyatt and Timken Roller Bearings

Welded Truck

A NEW type of shop truck, known as the "Weldsteel" truck has recently been placed on the market by the Pittsburgh Producers Supply Company, of Pittsburgh, Pa. It was originally designed for use in steel mills, particularly for handling wire in coils from wire or nail mills or sheets, plates, and similar material from sheet mills, or any like service. It has also been found suitable for use in other industrial plants where heavy loads are to be moved, such as brick plants, cement mills, crucible works, etc., it is claimed. It is also stated that the truck has a rated capacity of three tons, with a safe overload capacity of 100 per cent. It is very compact, the dimensions being 5 feet long by 3 feet overall width, and $3\frac{1}{2}$ feet overall height.



Three-Ton "Weldsteel" Truck for Heavy Service

The truck is made entirely from steel sections, welded together, no rivets being used. The body proper is made from four heavy channel sections, lap welded to the four angle sections forming the uprights. The uprights are braced by angle sections which are butt and lap welded to them and the frame is given greater rigidity by gusset plates at all four corners. In the case of the truck shown in the illustration V ends are provided so that when it is loaded with wire coils set perpendicularly, a pipe, or steel bar, can be passed transversely through the load to permit its being lifted as a unit by a crane. The V ends are also braced by gusset plates welded to the frame.

The main axle is supported by a cannon box mounting, made of welded angle sections, and firmly braced by angle sections running to the pilot wheel supports. The wheels are also of welded construction, the tires and hubs consisting of flat sections, rolled to shape, and butt welded. The spokes are made of heavy flat sections welded to the hub and tire. The wheels on the main axle are equipped with Timken Bearings.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

DRINKING FOUNTAINS—The various types of Halsey Taylor sanitary drinking fountains are described in Architects' Catalog H.—The Halsey W. Taylor Company, Warren, Ohio.

CLUTCHES—Bulletin No. 25 contains a description and tables of dimensions of Mule-Pull clutches, types G and ER. —Brown Engineering Company, Reading, Pa.

SPEED INDICATOR—A description of the Weston electric speed indicator is contained in Bulletin No. 4400.—Weston Electrical Instrument Company, Newark, N. J.

TURBINE BLOWERS—A booklet, recently issued, outlines the results obtained by the use of Wing Forced Draft Blowers in both hand-fired and stokered plants. — L. J. Wing Manufacturing Company, 154 West 14th Street, New York, N. Y.

WINDOWS — Catalog J-28 contains illustrated descriptions of Boca solid steel projected windows and the Boca bronze ventilator guide.—The Bogert & Carlough Company, Paterson, N. J.

HEATING—The report of the electric water heating test on low wattage heaters, conducted at the Russell Sage Laboratory of Rensselear Polytechnic Institute has been announced and is now ready for distribution. A copy may be had upon request.—Hynes & Cox Electric Corporation, 406 North Pearl Street, Albany, N. Y.

CRANES—A new two-speed handpower crane is described in a recently issued bulletin, No. 185.—Whiting Corporation, Harvey, Ill.

BRASS GOODS—Catalog No. 28 contains the entire line of Sherman brass goods, including brass hose and pipe fittings, plumbers brass supplies, lubricating devices, etc.—H. B. Sherman Manufacturing Company, Battle Creek, Mich.

BRANDS — Electric burning brands equipped with Chromalox heating units are described in Bulletin 3110.—Edwin L. Wiegand Company, 422 First Avenue, Pittsburgh, Pa.

CONTROL EQUIPMENT—Catalog GEA-606 furnishes information on representative lines of industrial control manufactured by this company. It also includes instructive matter on the care and operation of control devices, wiring diagrams of standard controllers, push buttons and other accessories.—General Electric Company, Schenectady, N. Y.

SPEED RECORDERS—Bulletin No. 328 contains a list of some of the industries in which these meters can be used, together with a description of the meter elements.—The Esterline-Angus Company, Indianapolis, Ind.

MOTORS—L. A. Inverted rotary converters, slip ring, and squirrel-cage motors, are described in a series of bulletins recently issued.—The Louis Allis Company, Milwaukee, Wis.

BALL BEARINGS—A new folder containing dimension and load data and price lists on New Departure ball bearings has just been issued.—The New Departure Manufacturing Company, Bristol, Conn.

METERS—Bulletin No. 75 illustrates and describes in detail the type HB maximum demand register.—Sangamo Electric Company, Springfield, Ill.

OIL HEAT—"Installing Oil Heat" is the title of a recently issued manual for the information of architects, builders, heating engineers and oil men.—Oil Heating Institute, 420 Madison Avenue, New York, N. Y.

COUPLINGS — Several new pieces of descriptive matter have been issued recently on Parker tube couplings. These include a desk folder with technical data and price list, and a pocket size folder containing specifications and instructions for the installation of these couplings.—Parker Appliance Company, 10320 Bearea Road, Cleveland, Ohio.

STARTERS — Bulletin No. 112 contains a description, ratings and dimensions of Monitor Thermaload starters. —Monitor Controller Company, Baltimore, Md.

CHART—Dolph's Solvent and Calculating Chart has just been published and is now ready for distribution. A copy of this chart may be had upon request.—John C. Dolph, 168 Emmett St., Newark, N. J.

ROLLING DOORS—A bulletin recently issued, contains an illustrated description of the Cornell line of steel rolling shutters and doors; Underwriters labeled rolling fire doors and shutters.—Cornell Iron Works, Inc., 36-20 Fifteenth Street —36-15 Twelfth Street, Long Island City, N. Y.

BELTS—The principle of the Tentacular belt is explained in a folder recently issued.—Alexander Brothers, Inc., 14 South Street, Philadelphia, Pa.

STEEL STRINGERS—Steel stringers for flexible overhead power transmission layouts are described in Bulletin SC-2. —Midwest Steel & Supply Company, Bradford, Pa.

FILING EQUIPMENT—A new 24-page booklet has just been published on a system for the filing and indexing of maps, plans, drawings and similar large sheets. A number of installations and various types of filing units are shown in the booklet.—The Globe-Wernicke Company, Cincinnati, Ohio.

GROUND CONNECTIONS — Technical Bulletin 1185, recently issued, is devoted to the measurement of the resistance to earth of ground connections. It includes a description of the new direct-reading "Megger" ground resistance tester; a comparison of the various methods of test, and data on the characteristics of earth.—James G. Biddle, 1211-13 Arch St., Philadelphia, Pa.

TRACTORS—A complete list of specifications and a pictorial story of the many uses of this machine, are contained in a recent folder on the Monarch 50 Tractor.—Monarch Tractors Corporation, (Subsidiary of Allis-Chalmers Manufacturing Company) Springfield, Ill.

MAGNETIC CONTROLLER—A description of the several component parts of the E.C. & M. magnetic controller is contained in a new folder.—The Electric Controller & Manufacturing Company, Cleveland, Ohio.

CATALOG AND DATA BOOK—The new General Catalog 500 consists of 1088 pages of engineering data and list prices on the complete Link-Belt line of chain and sprocket power transmission, and elevating and conveying machinery. In addition, it contains considerable information of value to the engineer.—Link-Belt Company, Chicago, Ill.

AIR COMPRESSOR—Bulletin No. 140 describes a multiple belt driven semi-portable air compressor unit, arranged for automatic start and stop control.—Pennsylvania Pump and Compressor Company, Easton, Pa.

LUBRICATION—A number of recent advertisements have been reprinted and published in book form describing many applications of the Madison-Kipp Fresh Oil System.—Madison-Kipp Corporation, Madison, Wis.

CABINETS—A new folder has been prepared for insertion in the Durabilt Catalog. This folder, No. 5050, contains a description of the Durabilt line of steel lockers and wardrobe cabinets. —Durabilt Steel Locker Company, Aurora, Ill.